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DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

F. E. SCHMITT, *Editor*

Volume 104 NEW YORK, JANUARY 2, 1930 Number 1

HIGHWAY PROBLEMS OF TODAY

Sound Financing Has Become the Critical Difficulty and Will Control Future Progress

WITH the opening of the year there looms up in impressive magnitude the continuing enterprise of modern road building to which the country has been devoted for now nearly ten years. The time is signalized also by that cosmopolitan gathering of the highway clans which marks the annual convention of the American Road Builders Association. Changed problems of the road field come to attention at this time, and new alignment of road thinking is accomplished.

Many new problems are coming into focus. A year ago the need for modernization of road planning and engineering was prominent. Since then, road finances have taken on commanding importance, so much so as to make it apparent that the entire future of road work is dependent upon them.

HIGHWAY finance and highway engineering are the controlling factors, but financing today comes first. It is on this basis that the articles brought together in this issue have been chosen. The facts and conclusions which they offer invite careful attention if the fiscal necessities of one of the greatest tasks ever undertaken in public-works administration are to be met. The present ways do not lead to this meeting.

Financing hitherto has been mainly a practice of expediency. It was almost inconceivable that the results should be otherwise with 48 governments having varying constitutional powers, different traditions of taxation and many degrees of wealth, inhabitation and highway development. This does not lessen the obligation for improvement. Vast sums of road money are being secured—nearly a billion and two-thirds dollars annually. By this measure the practice being followed is a success; it fails in not being predicated on road building as a continuing business only recently undertaken, still far behind the demands and with a long future demand ahead. It fails also in not budgeting and allocating expenditures on the basis of surveyed traffic demands.

THERE has been highway financing, but no highway financial system. This situation leads to excess in forms of taxation easy to impose, to confusion in the public mind of sources of income and to opportunity for political demagogism in pitting interest against interest. All of these evils have already descended upon American road building. They are growing into a danger which must be suppressed.

In the pressure of providing roads and still more roads sight is being lost of the fundamental truth that road building rests on general approval and that this is as fully subject to the law of diminishing returns as is a mercantile business. Without continued satisfaction as to value and allocation of charges for roads the demand for roads will not continue. They will hold popular support only on the supposition of efficient and well-adjusted planning, reasonable extent and distribution of work and a reasonable and equitable cost burden. These conditions do not exist today, and unless engineers look well to the future they will not develop.

Indications of discontent are not lacking. General taxes are being attacked, motor-vehicle taxes are being declared illogical and gasoline taxes excessive. Gasoline tax division and diversion are openly criticised and censured. Political and bloc interests, taking advantage of this discontent, are making attempts on the public treasury for diversion and reallocation of federal aid. They gain success because of confusion in the minds of the people as to the sources of money for public roads. They are encouraged by the prevalent juggling back and forth among state, county, township and nation of highway money and by the use of various disputed agencies of credit for realizing funds.

WHAT is the solution? In general it is the prompt creation of a more scientific and businesslike system of financing road building as a continuing industry. Specifically this calls for the selection of road systems to be improved according to relative importance and for a definite allocation of duty in financing these roads to state, county and township. It calls for budgeting and accounting. Engineering traffic surveys furnish the means of determining system distribution and mileage among state, county and township and of determining justifiable expenditures as between systems and upon the several parts of a system.

The articles in this issue provide an inspiration for constructive thinking in highway financing. They epitomize the evolution of highway financing, the present origin and distribution of funds for highways, and problems which are arising in our rapidly mounting imposts on the vehicle owner for his use of the public roads. They indicate as clearly the trend in engineering thought on the highway considered as a tool of transportation—its alignment, grades, width, surfacing, marking and signaling and general safety to travel. Both lines of thought have to continue and grow in energy and purpose if highway development in America shall remain a credit to engineering.

Trunks and Feeders

SINCE the beginning of systematic work in building up a countrywide network of improved roads, all road activity has logically centered on this objective. Within very recent years, however, improvement of local or feeder roads has engaged much interest, even to the extent of proposing federal money contributions. Inasmuch as nine out of ten miles of road are local, there is no doubt of the importance of the subject. Local roads have a necessary place in discussion of major road problems; but it is vital that they be considered from the viewpoint of sound and consistent road policy.

Among the reasons urged in favor of a new aid policy directed to the local roads is that they are the ultimately important means of connecting the farm with its markets. This claim has at best only a narrowly limited meaning, since the trunk roads connect the market centers, and the local roads are mere laterals or feeders of the trunks. But real weight resides in another reason—namely, that the financial and technical strength of local communities is insufficient for adequate improvement of these roads. It is in fact the controlling reason, and there is no need for considering minor arguments—such as that the total of road construction can be increased by including the byroads in the government-aid program—for they are largely fallacious. The case rests on the ability of the local units to improve their roads.

To appraise the situation we have first to consider the fundamentals of the established plan of road construction. The plan is to improve a unified network of trunk roads throughout all states of the country, by applying the joint resources of state and nation. Its purpose is to make road service available as rapidly as possible to all of the population. This purpose became the fundamental principle of the work, because it is self-evident that only by building the main arteries first can the benefits of improved road service be extended everywhere within a reasonable period of time. Practical proof that the principle is sound can be found in the success achieved in putting the road system to work and in holding the support of the people at large.

The reasons which led to devising this plan of road construction are still good. Hardly a third of our main network has been brought to a good-road standard, and many thousands of miles are still raw earth, changing to mud, dust and ruts under varying attacks of the weather. To complete the system is as urgent an objective as ever. Only by continued concentration of effort and money upon the trunk-road program can it be carried through in reasonable time. Any scattering of effort and money to the local roads will detract from its progress. A local-road policy which does not recognize these facts cannot be sound.

Looking at the condition of the local roads, it becomes apparent that they have many phases which will repay study. Their planning, administration, construction and financing present serious difficulties. Some of the many questions on the side of finance and administration are suggested by Samuel Eckels' outline of local-road finance in Pennsylvania. On the side of engineering, the extensive discussions of low-type and medium-type roads that have been going on during the last half-dozen years are evidence enough of the magnitude of the problem. A large field is open to research into the technical details of local roads, and extensive work will be required before a solution is found; fortunately, the study of these matters is already in progress.

In dealing with the problems of administration and finance, much is to be gained through co-ordinated planning. Through-routing, opening and abandonment of roads, order of improvement, width, surface, maintenance, are fields in which the local authorities cannot effectively think or act alone. They would find great value in the aid and co-ordination which the state highway department can give. Properly done, such assistance would be of utmost value in vitalizing the efforts of the local officials and imbuing them with that efficiency and conscientiousness of effort which distinguishes the work of most of our state highway organizations. In time, a powerful resource of knowledge and skill would be built up in the local groups by this procedure. Finally, the financial problem would be reduced to its true proportions.

Such financial support as local road work now receives through state aid is in general only a random and temporizing effort at stimulation and at solving the problem of funds. Funds are a critical factor in the case, as is clear from Mr. Eckels' figures. A county having only a few hundred dollars of annual road income cannot accomplish lasting results in road improvement. But the correction of such misadjustments is to be sought through careful planning, including a proper determination of what are local-service roads, rather than through indiscriminate charity. A community that has more miles of local road than it is able to support is insolvent and ought to go out of business; it can be made solvent only by abandoning roads until its mileage is cut to a self-supporting figure.

Clear and firm policy in prosecuting the road program is increasingly important as the attacks upon road improvement grow in number. Already road moneys are being diverted to other purposes in many parts of the country, and the trend to such diversion is growing. Roads are coming to be looked upon not as something needing support but as something to be exploited. Politics, greed, partisan and local advantage seek to fatten on the public roads. If these attacks are not to end in a sapping of the strength of the road campaign, the force of basic purpose must be maintained undiminished. And this purpose is the completion of the trunk-road system.

Local roads are eminently worthy of careful study of their many-sided problems, but they remain local problems. If they are allowed to dilute and distract the energies devoted to the trunk-road system, the road movement as a whole will be the loser.

Broader Thinking in Road Engineering

ENGINEERING thought in road building has centered successively on highway promotion, on roadway structure and on road service. At present there is being witnessed something like a sublimation of the idea of service. The articles in this issue on trends in engi- thought and inciting invention. A few years ago the road marking and signaling, road safety and multiplication of road mileage, as matters which are absorbing thought and inciting invention. A few years ago the stress would have been placed on paving-slab design and structure and on construction procedure.

This development of emphasis first on one and then on another phase of road engineering has had the natural consequence of creating exceptional perfection of detail in road structure at an evident sacrifice of creative think-

ing on broader problems. Highway system planning, economic highway location, the development of separate function roads, the efficiency of multiple-lane highways in contrast with parallel roads, are all unfamiliar speculations compared with the details of pavement structure, lane marking and sign location. As in highway financing, there has prevailed in highway engineering complete satisfaction in answering the immediate need without appraising future requirements.

The broader problems of road engineering require study. Today highway engineers are not prepared with the facts for their solution nor are they sure of the factors involved. They are not ready to answer the questions of the constructive legislator nor to disprove the claims of the propagandist. In the face of this weakness many serious evils have grown up. Legislative logrolling has in less than a decade added a hundred thousand ill-considered miles to state road systems. The enfranchisement of toll bridges has flourished. Continuous battle is being waged for diversion and dissipation of tax money. In short, engineers have been too occupied in detailing structure and catering to travel to prepare themselves adequately to defend the cause of sound transportation engineering, and in consequence the cause has suffered and is in danger of suffering still further injury.

Recently Thomas H. MacDonald made a significant remark: that the present road network is too large, and that many miles of road should be abandoned and returned to productive use. In this simple statement lies a powerful reminder of the notorious fact that roads as they now exist are the result of chance growth, opened in most cases to meet a local need which perhaps was temporary and is now outgrown. So long as only trail or unmaintained dirt road is at issue, this matters little. Now that a costly structure must replace the trail, the results of this random evolution will no longer do. Studied planning alone can give adequate justification for the enormous expenditures, direct and indirect, which present-day road construction and road service involves. The day is at hand, to repeat, when refined engineering investigation and planning is the necessary prerequisite of road work.

A hint of the constructive possibilities before the engineer is contained in the articles by Commissioner Burton and Professor Crum. Research of the broad character indicated by the director of the Board of Highway Research is a particularly vital need, and it has scarcely commanded the attention of interested discussion in the association work of highway engineers.

There need be no recession from perfect design and construction technique to give study to these general transportation problems. Indeed, this study calls for a different and separate type of workers only indirectly concerned with design and construction details. But early beginning is necessary. No time should be lost in injecting this new planning element into the engineering of state highway departments.

A Word on Society Influence

IN HIGHWAYS, as in other departments of technical work, growth of knowledge is closely interrelated with society activity and discussion. Exchange of thought by the medium of societies brings about the dissemination of the data of practice, and indeed helps to create them. This constitutes the prime value of society activity. A corresponding responsibility attaches to technical organizations: to maintain their work and their influence strong, in order that they may be a force of progress.

If these well-known matters are here repeated it is because with many difficult highway questions now pending, the help of virile, well-directed society work is essential to their early solution. Chief concern is not about the engineering questions among them, since these are fairly well provided for in several existing organizations, but about the larger questions of wise policy and due adjustment of procedure to prevailing conditions and views. Their effective consideration requires a general assembly in which the different types of men concerned in highways meet for full interchange of thought.

Such meeting of minds is less common and likely to be less efficient than technical discussion, but under present conditions it is by far the more urgent need. There is reason to doubt whether highway organizations as they now are make adequate provision for it. Should fuller examination confirm this doubt, a restudy and reformation of society work in this field would be in order. The American Road Builders Association, as the only society of comprehensive scope, bears the main responsibility in this direction.

To enlarge upon the present need briefly: The objectives of society work, be it remembered, are not limited to promoting the growth of knowledge. Two other functions are primary—knitting together the field by bringing into close contact such diverse elements as engineering administrator, student and operator; and crystallizing the best judgment of experience in the form of reports and conclusions which will guide future work. Considering these different services, do present highway organizations fulfill their mission with entire success? The answer, we fear, will be in the negative.

Close contact of all elements within so large a field as that of highways cannot be brought about by group or sectional meetings alone, nor in the discussion of specialist affairs. The purpose requires that the broad controlling questions of road construction be brought out into the open and analyzed in general meeting where all sides can be illuminated.

The purpose of these lines is not to attempt comparison. The four or five organizations in the highway field have distinct areas of operation, and each has full opportunity for service and growth. The present purpose is to point out the great opportunity for sound influence which lies before road organizations. Upon them rests the responsibility of realizing the opportunity.

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Engineering News was founded in 1874 by George H. Frost, as The Engineer and Surveyor, which title subsequently became The Engineer, Architect and Surveyor, then Engineering News and American Railway Journal and finally Engineering News, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as The Plumber and Sanitary Engineer. The name was subsequently changed to The Sanitary Engineer, Engineering and Building Record, and, finally, to Engineering Record. During his ownership of the paper Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded in 1913 by E. J. Mehren.

The Contractor was consolidated with Engineering News-Record in 1918.

E. J. Mehren became editor of Engineering News-Record at the time of the consolidation in 1917, and was succeeded by the late Frank C. Wight in 1924. In July, 1928, F. E. Schmitt was appointed editor.

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Thomas Harris MacDonald, chief of the U. S. Bureau of Public Roads since 1919, was born in 1881 and was graduated from Iowa State College in 1904. He was chief engineer of the Iowa State Highway Commission until his appointment to his present position

How Highway Financing Has Evolved

By Thomas H. MacDonald

Chief, Bureau of Public Roads, Washington, D. C.

A revolution in highway financing has occurred in the decade and a half since federal aid for public roads was inaugurated. Annual expenditures have increased to a billion and two-thirds dollars. About a billion dollars is raised annually by special taxes imposed on the road user. In what manner have these changes evolved? Answer is made in this article from the records of the Bureau of Public Roads.

The modern period begins with the bicycle, but progress was rapid only after the automobile came into wide use about 1914. Two years later federal aid was inaugurated. With the automobile begins the switch from property taxes to users' taxes, which now dominate all others as sources of highway revenue.

The story is statistical and is told here in figures of state and local income for highway purposes.

THE annual cost of our highways, exclusive of the streets in municipalities, is $11.92 for each person. It averages $58.13 for each registered motor vehicle. If, however, that part of the total expenditure which comes from the motor vehicle direct in the way of registration fees and gas taxes is deducted, the per capita cost from other sources becomes about $6.92. Carrying this thought one step further, if the expenditures for 1928 are reduced by the direct income from the motor user and by the amount of the proceeds from bonds, the interest and principal of which are carried wholly from motor-vehicle revenues, the per capita cost remaining to be met from other sources becomes $5.71. Of this amount, the state road systems take $1.39 and the local roads about $4.32 per person.

Thus, of the present per capita cost of $11.92, the motor vehicle supports directly $6.21 and all other sources $5.71. These are based on 1928 figures, but the sources and expenditures for 1929 will not be sufficiently different to disturb the comparisons materially.

The two outstanding features in the evolution of highway finance are: (*a*) the increase in annual expenditure, and (*b*) the proportion of the whole cost transferred to the highway user through special taxes. Our highways, rural and urban, have become, from the public financing viewpoint, large income-producing properties. This transition, from the time that the roads were looked upon financially as a burden beyond the possibilities of the taxpayer to meet adequately, has been rapid—so rapid, in fact, that it is hardly proper to use the term "evolution" in discussing the subject, since it is more properly a "revolution." That is, the two most important characteristics noted here are both the products of the past decade. These facts are well brought out by the two schedules: Sources of State Income for Highway Purposes; and Sources of Local Income for Highway Purposes, Tables II and III.

Broadly speaking, there are two periods in which highways have taken a vital part in our scheme of transportation needs.

During the first period, from colonial days, the highways grew in importance up to the time when they were carrying, say around 1830, an ever-growing commerce inland from the waterways. From this high peak the railroads gradually supplanted them. They receded as matters for state or federal concern, until by about 1850 they were left almost wholly to the care of the localities.

The second period began with the advent of the bicycle in about 1890, but attained only moderate headway until the tremendous increase in the use of motor vehicles prior to but especially following 1914. With the passage of the first federal highway legislation in 1916 the federal

Vermont—Macadam pavement typical of that used in reconstruction between Vergennes and Middlebury

California—Heavy grading taking out a cut 150 ft. wide for a new 48-ft. roadway

TABLE I—INCOME OF STATE HIGHWAY DEPARTMENTS BY MAJOR SOURCES

	1923	Per Cent	1925	Per Cent	1928	Per Cent
Bonds, notes, etc.	$88,186,784	18.9	$141,402,022	21.4	$121,483,599	14.3
State taxes	24,348,478	5.2	21,489,004	3.2	11,955,782	1.4
Appropriations	37,461,579	8.0	33,390,642	5.0	42,468,386	5.0
Miscellaneous	15,498,492	3.3	15,051,966	2.3	12,611,916	1.5
Motor-vehicle fees	147,075,966	31.4	199,845,163	30.1	259,134,820	30.5
Gasoline taxes	15,872,884	3.4	89,328,340	13.4	234,163,826	27.6
County funds used	66,753,265	14.3	71,737,028	10.8	86,709,904	10.2
Federal aid	72,343,401	15.5	92,180,406	13.8	80,798,365	9.5
Totals	$467,540,849	100.0	$664,424,571	100.0	$849,326,598	100.0

government again became concerned in the development of adequate highways, and the tendency now is for the state and federal governments to take an ever-increasing interest in the development of our road systems.

During colonial days, with the population largely centered around the waterways, there were only small beginnings in the use of overland transportation, especially when compared with the vigorous efforts, following the Declaration of Independence and the establishment of the nation, to extend commerce inland. From 1775 to 1850 highways were at once the means and the limitations of the development of the country inland from the waterways. Both the states and the federal government engaged in the furtherance of through roads. During this period the states east of the Ohio encouraged the establishment of toll roads by granting franchises to private corporations and by buying shares in these companies.

In addition to the encouragement of toll roads, the states at public expense engaged in the laying out and building of roads, and the federal government constructed the National Pike from Cumberland westward to the Ohio Valley with funds from the federal treasury.

1850 to 1890

Following 1850 the railways had supplanted highways for overland transport, and the highways reverted quickly to local control and financing. During this period there was the beginning of cash taxes specifically levied for road and bridge purposes. One of the first of such taxes, in Baltimore County, Maryland, as early as 1766, provided for a tax of 10 lb. of tobacco for each person.

In general, however, the road tax to be paid in labor, a tax which reaches far back into history, perhaps even to the time when it was an obligation of servitude, was largely relied upon to provide for the roads until long after 1850. As late as 1904 it is estimated that perhaps as much as 50 per cent of the taxes on property for road purposes was permitted to be paid in labor—that is, in 1904 the best available records show that of the total estimated expenditure for the year of $80,000,000 for road and bridge purposes, 59 per cent was paid in labor, 34 per cent in cash from property tax, 4 per cent was received from the proceeds of local bond issues, and 3 per cent from the states as state aid.

During this whole period from 1850 to 1890 the only important progress in highway finance was the levying of property taxes in cash and the growth of sentiment to secure the payment of the equivalent of labor taxes required in cash.

TABLE II—SOURCE OF STATE INCOME FOR HIGHWAY PURPOSES

Source	1904 Amount	1904 Per Cent	1921 Amount	1921 Per Cent	1925 Amount	1925 Per Cent	1928 Amount	1928 Per Cent
1. Motor-vehicle fees	.....	....	$101,284,479	25.1	$199,845,163	30.1	$259,134,820	30.5
2. Gasoline tax	.....	....	3,273,988	0.8	89,328,340	13.4	234,163,826	27.6
3. Sale of bonds and notes	.....	....	111,396,637	27.6	141,402,022†	21.3	121,483,599†	14.3
4. Transfers from local authorities	.....	....	35,344,175	8.7	71,737,028	10.8	86,709,904	10.2
5. Federal aid	.....	....	77,456,687	19.2	92,180,406	13.9	80,798,365	9.5
6. Appropriation from general funds	$2,607,323*	....	34,431,897	8.5	33,390,642	5.0	42,468,386	5.0
7. Miscellaneous	.....	....	8,079,391	2.0	15,051,966	2.3	12,611,916	1.5
8. Tax levy	.....	....	32,800,901	8.1	21,489,004	3.2	11,955,782	1.4
Total	$2,607,323	....	$404,068,155	100.0	$664,424,571	100.0	$849,326,598	100.0

*Used for state aid roads. †Largely supported by motor-vehicle revenues.

Period of State Aid and Early Federal Legislation, 1890-1916

A really important milestone was set up in the progress of modern highway financing when the State of New Jersey in 1891 provided for aiding the counties through funds appropriated by the state.

The financial report for 1904 shows that these states had aided the counties during the year in some degree: California, Colorado, Connecticut, Delaware, Maine, Massachusetts, New Jersey, New Hampshire, New York, Pennsylvania, Rhode Island, Utah and Vermont. The total for these thirteen states of such aid was $2,607,000, of which Massachusetts, New York, Connecticut and New Jersey supplied about $2,000,000, leaving the remaining $600,000 to be divided among the nine other states.

Michigan—Concrete viaduct over two railroad lines. Roadway of concrete, 40 ft. wide, also two 6-ft. walks

Kentucky—Retread on gravel, typical of the low-cost roads used to open up isolated districts of the state

In 1902 Rhode Island provided for laying out and building at state expense a system of state roads. Other states followed soon after, including Connecticut, Maryland and California. In addition to these, others which did not assume full responsibility for building a system of roads did provide funds which were required to be expended upon a definite system covering the main traveled routes of the state. In 1916 the present federal-aid highway legislation was passed, the original appropriation being $75,000,000 to be expended over a period of five years on the basis of equal participation by the states. The sources of income of the state highway departments, including the federal funds, 1923 to 1928 inclusive, is indicated in Table I.

From this schedule it will be noted that bond issues have been an important source of state highway income. Prior to 1913 all issues of state highway bonds were financed from proceeds of general property taxes, fees or other taxes levied by the state. In 1913 Maine established the procedure of issuing bonds at the rate of $500,000 per year for highway purposes, the issues to be financed from the proceeds of the motor-vehicle tax. This plan quickly spread to other states, and at the close of 1928 the total state highway bonds issued since 1894 amounted to $996,000,000, of which $670,000,000 are being retired from the motor-vehicle income and $14,500,000 from bridge tolls. The only states that have state bond issues of any considerable size to be financed from general property taxes are California, Maryland, Massachusetts, Michigan, New Jersey, New York, Pennsylvania, Rhode Island and Vermont. The use of this plan of financing extraordinary expenditures above current income is the method through which we are securing now the larger proportion of the annual mileage of paved roads.

The gasoline or motor fuel tax for road purposes was first applied in Oregon early in 1919. The idea was quickly followed in North Dakota, New Mexico and Colorado. It is recorded that this source of revenue was proposed as early as 1915 by President Wilson as a national tax, but the recommendation was not followed and the federal government has left this field open to the states. In Oregon the first tax was 1c. per gallon on gasoline and ½c. per gallon on distillate. At the present time all of the states have levied a gasoline tax, but there is no uniformity in the rate, which varies from 2c. to 6c., New York being the last state to adopt such a tax, which became effective on May 1, 1929. There has been a constant tendency to increase the rate of this tax. The average rate for all states in 1928 was 3c. and the estimated average rate for 1930 is 3½c.

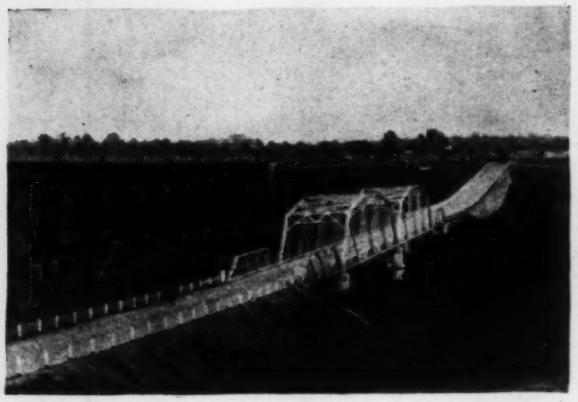
Since 1923, which is the first year for which reasonably complete financial data are available, state highway funds have increased at the rate of $64,000,000 per year. By far the greater part of the increase has been paid direct by the motor-vehicle user. This increase has averaged $55,000,000 per year, leaving an average of $9,000,000 from other sources, among which bond sales account for $5,500,000. Since these bond issues in practically all of the states which now use this method are financed and retired from the direct proceeds of the motor vehicle, almost the whole of the increase in state funds is met by the highway user as such and not by the property owner as such. The direct taxes on property for state highway purposes show an average reduction for this period of about $2,000,000.

Not only has the direct income from the use of the highways carried the burden of the increase in state expenditures but it has also contributed largely to the local income. In 1928 more than $100,000,000 went to the local units from this source. The legislation early in the year 1928 increased the tax rate on gasoline in about twenty states, and of these the increase in seventeen went to local roads. The reports, therefore, for 1929 will show a much larger percentage of local road income derived from this source.

TABLE III—SOURCES OF LOCAL INCOME FOR HIGHWAY PURPOSES

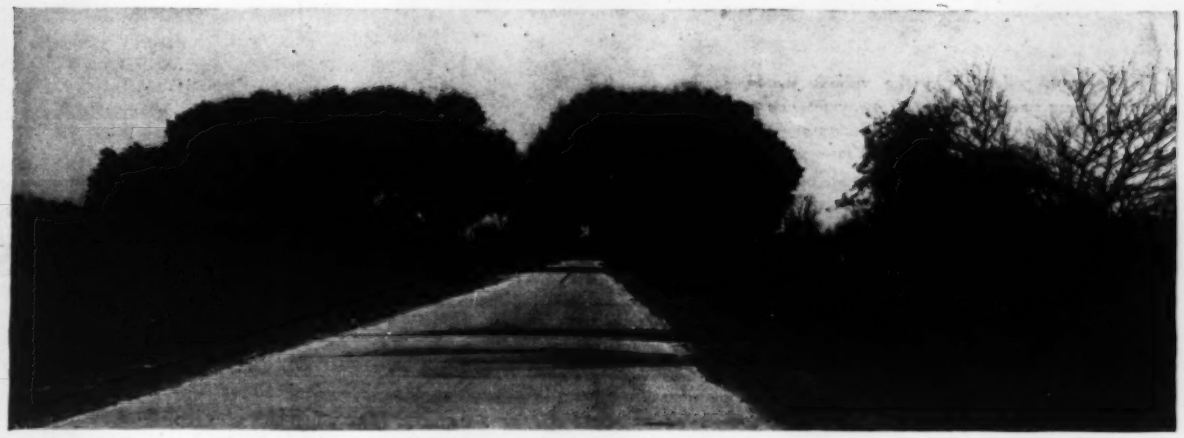
Source	1904* Amount	1904* Per Cent	1921 Amount	1921 Per Cent	1925 Amount	1925 Per Cent	1928 Amount	1928 Per Cent
1. Road tax levy	$53,639,388†	67.4	$348,513,837	46.9	$412,825,227	60.4	$416,812,566	49.9
2. Labor road tax	19,818,236	24.9	.....	.....	.....	.....	.....	.....
3. Sale of bonds	3,530,471	4.4	323,176,097	43.5	144,413,116	21.2	150,222,357	18.0
4. Transfers from general tax levy	.....	.....	.....	.....	.....	.....	81,948,993	9.8
5. Gasoline taxes	.....	.....	239,472	.....	24,833,979	3.6	53,778,852	6.5
6. Miscellaneous income	.....	.....	54,125,593	7.3	23,966,034	3.5	51,133,653	6.1
7. Motor-vehicle fees	.....	.....	15,116,937	2.0	46,545,445	6.8	50,433,055	6.0
8. Transfers from state fund	2,607,322	3.3	2,321,266	0.3	30,433,841	4.5	30,997,475	3.7
Total	$79,595,417	100.0	$743,493,202	100.0	$683,017,642	100.0	$835,326,951	100.0

*Figures given for 1904 are expenditures which were approximately the same as income.
†A considerable portion, one-half or more, of this amount was actually paid in labor.



Virginia—New highway bridge over the Staunton River to shorten route and eliminate grade crossing

Texas—Reconstruction of worn-out road in Nolan County. Cover material piled on the shoulders



Louisiana—Gravel concrete pavement 18 ft. wide, part of 438 miles under contract

In brief, therefore, the outstanding development in modern highway finance is the ability of improved roads to earn a large income with which to maintain those already improved and extend the mileage of new construction.

There is one other important method of highway finance which is applicable to specific projects, based on the same principle of the earning capacity of the highway facility provided due to the large and ever-increasing highway traffic. This is the revenue bond method, which may be illustrated by the financing of the bridge across the Ohio River at Louisville which has been recently thrown open to traffic. In this instance a municipal bridge committee was established, which was given authority under the state laws to issue bonds against the earnings of the proposed bridge but without authority to impose any liability for the debt upon the property of the city or to include the debt as a part of the municipal indebtedness fixed by the Constitution.

Fortunately, a committee of outstanding ability was appointed to act for the city, and in co-operation with a splendid banking house and a first-rank firm of bridge engineers, a financial plan was carefully developed which successfully met the scrutiny and received the approval of the courts of the state. This plan basically consists of pledging the revenues derived from tolls imposed for the use of the bridge to retire the principal and interest of the bonds, and when this indebtedness shall have been met the bridge is to become free to the public or the tolls reduced to the point of providing for maintenance only.

The bridge has been completed well within the estimated cost, and due to the care with which both the financing and engineering operations were administered, it is an outstanding example of the use of this method for financing such expensive structures in the interests of the public. Somewhat similar methods are being used by a number of the states, but the successful use of this principle requires such a high degree of specialized knowledge and experience, particularly in handling the financial set-up, that the same degree of success as that attendant upon the Louisville project has not been secured in a number of other instances.

There have been a considerable number of franchises granted in recent years for building toll bridges by private corporations or by individuals. These included some projects which were sound financial propositions, and many others where the probable traffic could not possibly support the cost of supplying the facility. In part due to the failure of some projects already built to provide an adequate income to carry the outlay, and in part due to the changed conditions of the bond market, bonds for privately owned toll bridges are not now in the favor of the investing public, and it does not appear probable that this method of providing such bridges will be followed to any considerable extent in the future.

As a general commentary, it may be said that the public has become conversant not only with the earning capacity of the highways, including bridges on principally traveled roads, but there are sufficient instances of public financing through bonds to be retired from such revenues that it is probable in the immediate future the public will undertake the financing of all major projects, either of general road building or of specific large individual undertakings.

Rhode Island—Post road at Pawtuxet River bridge; 36-ft. asphalt pavement on 6-in. concrete base

New Mexico—Salvaging old gravel roads by the premix method; processing done by the state

A. J. Brosseau, a leader in the vehicle world, is the author of many pamphlets on highway finance and taxation and writes with particular knowledge of the reactions of the motor-vehicle industry on these vital problems

Financing State and Interstate Highways

By A. J. Brosseau

President, Mack Trucks, Inc., New York City

Mainly statistical and interpretative, this article is directed to an expression of the following principles: Highway transportation is an essential element in modern-day life. All benefits from road improvement directly or indirectly, consequently general taxes, are justified for that purpose, and should be the means of finance employed until motor transport develops to a point where supplementary vehicle taxes can be used. The motorist receives a special benefit, hence supplementary special taxes on motor vehicles solely for road improvement are equitable so long as they do not constitute an undue burden on the individual. The gasoline tax is the simplest and most equitable form of motor taxation, but should not be relied upon wholly to support an adequate road program. The benefits are so great that deferred methods of payment are actually less costly than an attempt to build from current taxes alone. The nation and state have a direct responsibility in the financing of roads of more than local importance. All road improvement should proceed under a rational plan of administration directed first toward the systematic development of the most important highways in each nation or subdivision. The first step in any highway program should be to provide the public with communication. This can best be accomplished by adoption of a stage-construction policy by which the roads are improved to the extent necessary to allow traffic to use them and are raised to higher standards as the traffic develops. Adequate maintenance is a prerequisite to any successful highway program.

FROM an economic point of view, two questions should be kept in mind when trends of highway finance are under consideration. The first is, What are our traffic needs? and the second, How can we get the money to meet those needs with the least possible delay?

Despite the fact that the nation is spending $1,600,000,000 annually on the improvement of rural roads, there is no evidence that our road builders have caught up with the demand for highways.

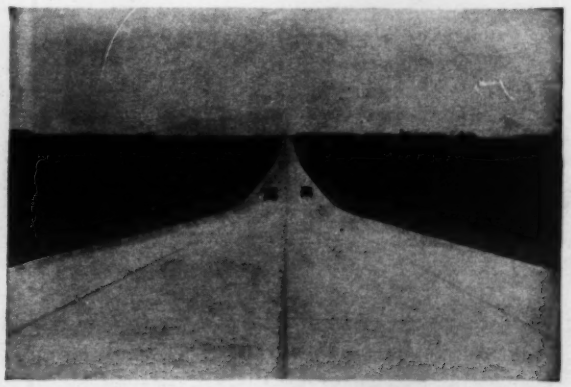
Traffic continues to grow year by year. Where passenger cars were virtually alone, a growing army of trucks and buses are now engaged in the business of hauling commodities and persons over the highways. There were 24,500,000 vehicles of all descriptions registered in 1928. Preliminary figures from the United States Bureau of Public Roads add 2,000,000 to that number as 1930 begins.

Not only do the number and character of the vehicles continue to increase but new uses are constantly being added to the wide variety of services which the public is demanding of these instruments of flexible transportation. Railroads are tying them into their facilities at terminal points and along main lines. There is a steadily increasing suburban use as cities expand. The movement for improved waterways necessarily carries with it highway connections. An important part of the modern policy of small inventories and the quickened distribution of goods rests upon the truck.

These and a thousand other factors compel the highway engineer to adopt new specifications which eventually come back to the fiscal authority in the form of new and pressing demands for funds. It is no longer enough that there shall be ways to travel between our cities and towns and country. Those ways must be strong enough and wide enough to carry a volume and density of traffic beyond past calculations. Since delay costs money, congestion must be relieved, and the relief of congestion means separated roads and arterial approaches.

Therefore, despite the fact that for ten years the highway engineers of the United States have been consist-

Missouri—Overflow section of highway with paved shoulders to prevent wash. Guide posts at the right



Illinois—Four-lane highway between St. Charles and Elmhurst; graded roadway 60 ft. wide, pavement 40 ft.

ently breaking all records in their efforts to provide adequate highway transportation facilities, the job is still far from completed and will not be completed for years to come. Were it not for the fact that the vehicle and the road contain within themselves wealth-creating elements, the task of providing funds might be overwhelming.

Thus far, highway finance has proceeded without adverse effects upon other uses for public funds and with a minimum of strain upon the taxpayers.

The whole philosophy back of highway development has been trenchantly summed up in two sentences by Thomas H. MacDonald, chief of the United States Bureau of Public Roads. The first of these was uttered several years ago and by dint of repetition has attained widespread acceptance and all the force of an axiom. It is, "It costs less to build roads than it does to do without them."

The corollary to this comment is contained in his recent address to the American Association of State Highway Officials at San Antonio, when he said: "There is not a single valid argument against the issuance of road bonds as a fiscal matter."

Present-Day Facts of Highway Finance

A working outline of present-day practices in highway finance can be had if to these statements of policy are added these statements of fact:

All states of the country except North Dakota have used bond issues as one means of financing their programs.

State bond issues are now generally financed from motor-vehicle taxes.

Motor-vehicle taxes will amount to approximately $1,000,000,000 in 1930, an amount equivalent to 63 per cent of the total annual program of $1,600,000,000 for all rural road purposes.

Special motor-vehicle taxes are now more in amount than the entire expenditures for roads in the main systems of the several states.

States generally are withdrawing from the field of general property taxation for main road building, leaving this source of revenue to the local authorities. Last year less than 8 per cent of state funds were drawn from property, while counties derived nearly 66 per cent of their income from land.

When modern road building began in the United States, the authorities had 3,000,000 miles of highways on their hands, none of which could be said to be of a quality sufficient to care for the needs of motor-vehicle traffic. The problem was one of selecting those roads which should be improved first and of providing the funds with which to do the job.

The first consideration was for county, state and federal road systems. The funds were secured from local, then general taxes, bond issues based on general taxation, motor-vehicle registration fees, gasoline taxes and federal aid, and finally state bonds based on vehicular taxes.

Today all methods are employed, but with notable differences in degree as compared with their uses at the outset.

Shift in Source of Taxes

Thus while general property taxes have always comprised the bulk of the income for local road purposes and probably will continue to do so for a long time if not always, the whole structure of state taxes has been rebuilt.

The motoring public has accepted the principle enunciated in Mr. MacDonald's statement that "it costs less to build roads than it does to do without them," with the proviso which has also been generally accepted that if the vehicle is to be subjected to a special benefit tax, its owner should receive a special benefit from the levy.

This attitude, coupled with a prudent limitation that in no case should the individual owner be unduly burdened, has brought enormous sums into play for the construction and maintenance of highways of general motor use. Even so, as the traffic has grown, the demand for immediate improvement of these roads has outstripped the capacity of current available funds.

Again the cardinal principle recited by Mr. MacDonald has come into play. First on faith, later on fact, authorities have turned to bond issues as an efficient means for hastening highway development.

Without going into detail, experience has demonstrated that the use of highway bond issues (*a*) expedites the construction program, (*b*) lowers maintenance costs, (c) lowers transportation costs, (*d*) increases the range of vehicle use, (*e*) adds to real wealth.

When these bonds are issued by state authorities, as they should be, for the construction of roads within the main systems, there is an added advantage in the fact that the credit of the larger is better than that of the smaller subdivision and consequently such issues cost less.

From these conclusions we come naturally, then, to Mr. MacDonald's second dictum, that there is no valid argument against highway bonds as a fiscal practice.

Viewed as an economic practice, Mr. MacDonald points out that there are a few states where there is no longer the need for this type of financing as a general policy

Maine—Typical condition of many highways in the state before improvement work started

Maine—Same highway rebuilt as part of U. S. Route No. 1, three lanes of 9-ft. concrete pavement

which existed a few years ago. But he also notes that "every state can still profitably issue bonds for certain purposes, if not for primary highway buildings, then for grade-crossing elimination, or needed bridges, or the provision of additional facilities for the relief of traffic congestion, or for any of the numerous improvements which remain."

To this might be added the viewpoint of the motorist as the man who is today paying for all of the state bond issues, that such methods of finance will not be justified unless the money so secured is concentrated solely upon those roads which will give him an adequate return upon his investment in the form of lowered transportation costs more than sufficient to offset the taxes paid. In that statement, of course, is implied engineering and economic control of the expenditures, and their direction to the development of roads of general motor use.

I have emphasized this question of bond issues, because the turn to this method is the most striking trend in modern highway finance and also because it enables me to anticipate the question of sources of revenue.

Sources of Highway Revenue

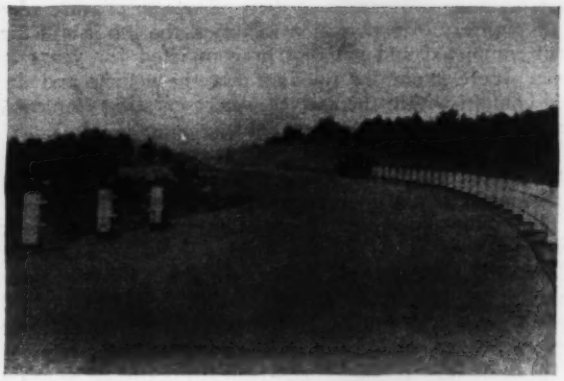
Stated broadly, the most important source of revenue today is the special motor-vehicle tax, which in 1929 will reach the following amounts:

Registration fees	$340,000,000
Gasoline taxes	415,000,000
Municipal taxes	25,000,000
Personal property	150,000,000
Total	$930,000,000

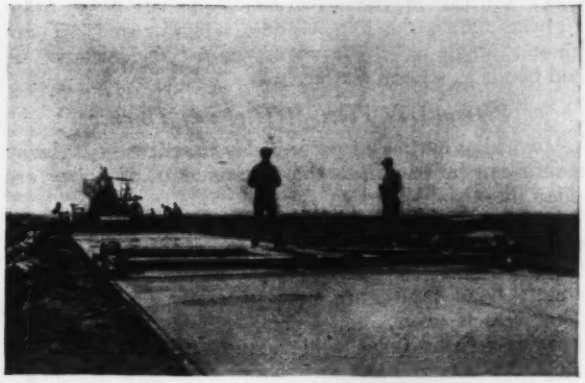
Not all of this amount, of course, goes directly to roads, but $755,000,000 of it does, and the remainder serves to offset the necessity for raising funds from some other source which otherwise would face authorities.

The other sources were federal aid, which is but 5 per cent of the whole, and general property, which now pays less than 8 per cent of the cost of state roads, but does pay 66 per cent of the $835,000,000 now devoted annually to the improvement of local roads.

Of these amounts the only one which is keeping pace with the increased road expenditures is the motor-vehicle tax. While in the past this increase has not been particularly burdensome to the individual, the additions to the rate of the tax have now reached a point where care must be used by fiscal authorities lest they encounter the point of diminishing revenue returns due to an actual restriction in the use of the individual unit. In other words, gasoline taxes in excess of 5c. per gallon result in less mileage, and when linked up with registration fees and the other charges the motorist must face, will return less revenue than a lower tax.



Utah—Compacted gravel on U. S. Route No. 91 across the state. Other portions are of concrete or bituminous pavement



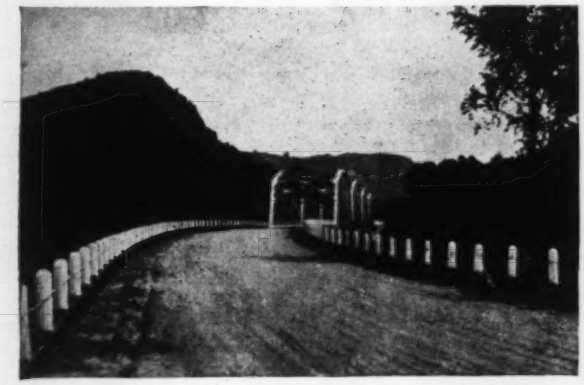
Colorado—Concrete road construction in the eastern part of the state between Greeley and Fort Morgan

The differences in charges per unit is another element deserving of study. Charges levied against bus and truck carrier operations have run the taxes of these vehicles to figures as high as $1,000 per unit per year, and the average bus tax today is $524. When vehicles engaged in interstate commerce pay the taxes in each of the states in which they operate, the charges become excessive. The only way in which they can be met is by added costs to the individual passenger, and carried too far, they deprive him of some of the uses of the road which as a taxpayer he has helped to build.

With buses paying 24 times the average tax paid by

Oklahoma—Heavy grading on a state-aid project in Cherokee County in the hilly section of the state

Ohio—Urban highway near Toledo. Brick laid on a concrete base with 1 in. sand cushion and asphalt filler



Wisconsin—Approach to Bad Axe River bridge—Wide and secure shoulders provided on embankment

Tennessee—Four-lane concrete pavement 36 ft. wide to the intersection of routes Nos. 1 and 15 west of Memphis

private motorists and trucks paying 25 per cent of the total, although they are but 10 per cent of traffic, it would appear that these vehicles are paying a disproportionate share.

Aside from the use of bond issues to spread the cost of the highway as between the present user and those who will profit from the improvement at a later day, the only suggestion which has been heard recently respecting new methods of highway finance is the revival of the oldest form of all—the toll.

Disregarding the fact that motorists are already paying tolls in the form of gasoline taxes, proponents of this idea would establish a new series of express highways which would link the country and for the use of which the motorists would be expected to pay as he rides. While the time is already here when express motorways between heavily congested areas of population are under consideration, such roads will be built only where the public interest is so general and so imperative as to warrant the state or states in undertaking the task, as in the case of the projected road across the Hackensack meadows in New Jersey.

It is conceivable that as in some instances states have constructed bridges, and charge tolls until the cost is amortized, so they may adopt the same policy for express highways in a few heavily traveled areas. Here again, however, the bond issue appears as a possible solution where the traffic warrants the investment.

It may be that highway plans for metropolitan areas will recommend special forms of taxation or assessments on adjoining property. Such taxes can be justified only if the improvement directly and substantially increases the value of the adjoining property. Such increase in value may come about by conversion of use—as, for instance, the changing of truck farms into suburban home sites or industrial areas, or both.

In two other respects trends of more than passing interest are developing in highway administration, which will affect highway finance. One is the addition of more miles of road to the state systems, the other is the demand for municipalities for a share of the motor taxes.

The expansion of state systems has the effect of releasing local funds for development of local roads. Concurrently, while it increases the cost of maintenance for the state, the net charge will be lower. Increasing motor-vehicle fees and gas taxes, and the use of bonds, have financed the costs growing out of this practice and in the past seven years have added more than 100,000 miles to the state systems.

The drive for municipal participation in motor taxes is not as yet serious. The only justification for such participation is the mounting cost of highway approaches and the fact that a large proportion of motor fees are paid by city dwellers.

Because of the fact, well established by surveys of the Bureau of Public Roads and state highway departments, that virtually all the travel on (use of) rural roads is by city-owned cars, it is not likely that the municipalities will insist on participation of motor taxes, at least not until the highways of general motor use are completed.

Meanwhile a review of the general situation indicates that while there are inequities here and there, the foundation of highway finance is sound.

Mississippi—Highway bridge over the Yazoo River north of Vicksburg. Approach trestles of creosoted timber

Florida—Single-strip concrete pavement with wide grassed shoulders to prevent wash of light soil

As instructor of economics and commerce in the University of Kansas, Edmund P. Learned made a careful investigation of gasoline taxes which was published as a university bulletin in 1925. He has been a close student of the subject for more than a decade.

Gasoline Taxes

Theory, Practice and Hazards

By Edmund P. Learned

Graduate School of Business Administration, George F. Baker Foundation, Harvard University, Boston, Mass.

All states now impose a tax on gasoline. In 1929 the total amount of this tax after deducting the cost of collection was $415,837,000. Of this amount about $229,765,000 was spent on state highways and $21,034,000 was employed for payments on bonds issued largely for state highway construction. Another portion of $74,564,000 was expended on county and township roads. A final $20,474,000 was spent for miscellaneous purposes, 60 per cent going for the improvement of city streets and 40 per cent for other purposes than highway improvement. During the year 21 states increased their gasoline tax rates 1c. or 2c. a gallon and two states formerly without gasoline taxes created them. The problems in rates, distribution and diversion which these figures indicate and the hazards which wrong solutions portend to road building are considered in the following article, which discusses tax rate limitations, tax distribution and diversion, and the reaction of business interests and the public toward recent legislation. In conclusion a sharp warning is sounded against the abuse of gasoline taxation.

WITHIN a period of ten years the gasoline tax has spread from Oregon, where it was first adopted, to every state in the Union. It is no longer experimental but is a standard device for raising revenue. The Oregon law became effective Feb. 25, 1919. North Dakota, New Mexico and Colorado soon enacted gasoline tax laws. At the beginning of the year 1921 five states had gasoline tax laws, all levying, with a single exception, 1c. a gallon. During 1921 eleven states were added to the roll of those using the tax. The year 1923 established a record for new enactments, with sixteen new laws. Increases in the rate of tax were common in 1923, though at that time a 3c. per gallon tax was considered high. By the end of 1925 New York, Illinois, New Jersey and Massachusetts were the only states without gasoline tax laws. One state had a 5c. tax, four states had a 4c. tax, thirteen had a 3c. tax and 24 had rates of 2c. or less. In 1929, however, with all states attempting to keep gasoline tax statutes on their books, the most popular rate is 4c. a gallon; 30 states have a rate of 4c. a gallon or more. Three states have rates of as much as 6c. a gallon.

A new tax which can sweep the country in a period of but nine years is truly a remarkable tax. Surely this form of tax must have unique economic or political attractions.

Theoretical Basis

The major purpose of gasoline taxes has been to raise funds for good roads. The motor-vehicle era required better roads than the horse-and-buggy age. Benefit districts, motor vehicle license fees and gasoline taxes—all these have had their place as sources of revenue for road building. The most potent argument for a gasoline tax has been that it measures the use of the road more accurately than any other tax on motor vehicles or than any other type of tax.

The benefit district had its place and still has its place as a source of funds for road building. It was used extensively in the early development of good roads in this country. Some of the benefit of good roads un-

West Virginia—Bituminous macadam on final link of U. S. Highway No. 30, which traverses the state

Alabama—Concrete highway laid on abandoned L. & N. railway grade. Cuts widened to 28 ft. and fills to 30 ft.

doubtedly accrues to those by whose property they pass. That some cost of roads should be borne by abutting property and the benefit district is admitted. Yet few would insist that all the cost of the road should be borne by those whose property it touches. Cars from cities use primary roads more than cars from country districts. For primary roads, at least, a large proportion of the cost of construction and maintenance of roads should be borne by those who use them. The share of the cost of the road which the abutting property should pay depends to a large extent upon the type of road concerned, primary, secondary or tertiary, and its location with respect to flow of traffic.

License fees on automobiles and trucks have been another means of raising funds to pay for better roads. These fees have their place, both as sources of revenue and as devices for the regulation of those who drive upon the road. Nevertheless, to increase license fees to an amount sufficient to pay the costs of road construction and maintenance is likely to lead to inequitable results as compared with the manner in which the gasoline tax operates. High license fees become an unfair burden on those who use their cars little, and become relatively light on those who use their motor vehicles a great deal. The gasoline tax, on the other hand, works out as would a system of toll roads: the user contributes toward the cost of the road only when he uses it.

As was suggested above, the tax on gasoline measures with some accuracy the wear and tear of the automobile on the road. The amount of gasoline consumed in a motor vehicle bears a direct relationship to both the distance traveled and the weight of the vehicle, the two factors that have a direct relationship to the wear and tear on the road. This argument in favor of gasoline taxes is well recognized and needs no further development.

The fact that the gasoline tax extends the benefit principle of taxation to users of roads who are not also abutting property owners makes it a virtually inevitable recourse to those states committed to the toll principle of road revenue.

It is desirable to note two other bases for supporting gasoline taxation. The first is predicated upon the ability principle of taxation in contrast to the benefit principle exemplified in the foregoing argument. It may be argued that an automobile is a luxury commodity, the ownership of which indicates material well-being and ability to share in the financial burdens of government. This argument has some merit; yet essentially it is little more than a weak attempt to substitute a gasoline tax for the income tax, which, carried to its logical conclusion, the ability principle requires. Indeed, the occasional attempt to generalize the application of revenue from the gasoline tax emphasizes this danger.

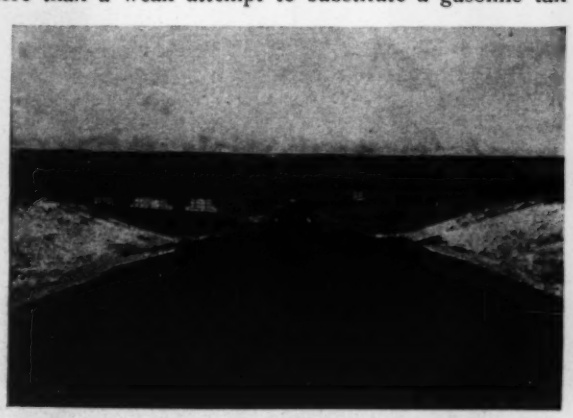
The place of the gasoline tax as a source of general revenue in any system of taxation depends necessarily upon characteristics of the tax system as a whole. It is an axiom in public finance that a tax which may seem unjust in some particular when viewed as an individual tax may still be found to be eminently just when viewed as part of a whole system of taxation. It is therefore impossible to make a general assertion about a gasoline tax as a source of revenue for general revenue purposes and to have the assertion wholly correct under all conceivable circumstances. Notwithstanding, the writer believes that the gasoline tax should be restricted to raising funds for use upon road construction and maintenance and not as a source of general revenue. The tax structure of many states, moreover, supports this view rather than the view that the tax should be used as a source of general revenue.

The remaining basis for gasoline taxation is one of economic policy with respect to natural resources. A very high tax on gasoline and other petroleum products —much higher than any tax now in effect—could be used to discourage the purchase and sale of gasoline and thus to encourage the conservation of valuable natural resources. Needless to say, the oil industry would oppose such measures to the highest court and would endeavor to keep public sentiment from indorsing such a policy. It is unlikely that this doctrine will have any influence on gasoline taxation programs during the immediate future.

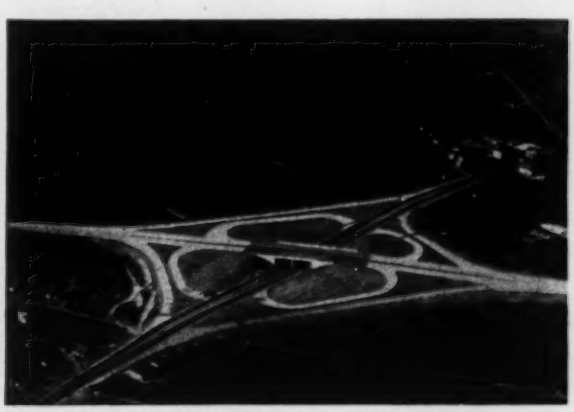
Tax Rate Limitations

Regardless of the theoretical bases on which gasoline taxes can be justified, there is no question that in effect they are sales taxes. As a sales tax the gasoline tax has the advantage of convenience of payment. The consumer of gasoline pays the tax when he buys gasoline. Only a small amount for taxes is involved at each purchase. As in indirect taxes, the real burden of the tax tends to be concealed in the price of the product. Yet the burden of the tax is present, and must, if the rate be continually raised, become perceptible and eventually onerous to the motorist. It must be remembered that the existence of the tax is due only to the approbation of its payers.

This latter point involves a brief examination of why the consumer has found the gasoline tax practically a burdenless tax. Automobile owners know that the first



Wyoming—Asphaltic oil-treated gravel, standard treatment for gravel or crushed stone in that state



New Jersey—Grade separation where new highway from New York to Philadelphia crosses another main road

cost of a car is not the largest cost. When the buyer of gasoline can see the operating costs for his car reduced as a result of the manner in which his contribution to gasoline taxation revenue has been spent, he is willing to support the tax. What he pays out of one pocket in gasoline taxes he avoids paying out of the other pocket in repair bills, depreciation allowances and general maintenance expense. This line of thought explains partly why the advancing rates of taxation for each gallon of gasoline have not caused unfavorable consumer reactions. Under a 5c. tax the consumer may not have any more expense for operating a car than he formerly had when roads were less satisfactory.

Although this argument is frequently advanced, it seems to the writer to be more nearly a rationalization than an interpretation of the public action. More important is the psychological satisfaction which users secure from the extension of good roads—a satisfaction so highly esteemed that they are willing to pay for it.

Maryland—Baltimore-Washington boulevard widened from 20 to 40 ft. by adding 10 ft. concrete shoulders and resurfacing old road

Though the consumer has not yet objected to gasoline taxes, it does not follow that there is no upper limit to gasoline tax rates. How high the tax rate will go is difficult to forecast. Rates will probably advance to the point where the majority of the community decides that the further luxury of good roads is no longer worth the extra cost represented by a higher gasoline tax rate. Though the gasoline tax has been a burdenless tax to many people, there are many who object to paying a 5c. tax, for example. But the tax has not modified their purchasing habits materially. They continue to buy gasoline when they need it; they do not vary noticeably the quantity of their purchases with variations up or down in the price of gasoline; their demand for gasoline is an inelastic demand. Under these conditions a substantial proportion of the tax is shifted forward to the consumers. If the majority favor the 5c. tax, the minority help pay the tax unless they refuse to buy gasoline.

It is pertinent to ask, however, if there would be as many 5c. and 6c. gasoline tax rates if the price of gasoline were 30c. a gallon without the tax. Under those conditions the final price of gasoline to buyers would be from 50 per cent to 100 per cent higher than it is in some portions of the United States today. The demand of users would still be relatively inelastic even at the price of 30c. to 36c. a gallon. Public sentiment in favor of gasoline taxes, however, could turn the other way. Through political channels, gasoline tax rates could be reduced. Just now this possibility seems remote—but the recent stock market crash was an unexpected happening to many people.

The question of stability in the gasoline tax rate as a source of revenue for road purposes is really important. A low tax rate is less likely to be reduced as a result of changes in the price of gasoline than a high one. Where there is stability in the revenue, bonds as a method of financing are more sound than they are where there is lack of stability. In laying out the financial program for highways in a given state it would seem desirable to give some attention to long-time prospects for stability in the gasoline tax rates. Nor is it advisable for legislators to expect that gasoline will always be as low in price as it has been in the past few years.

Unless the state decides as a matter of public policy to tax the oil industry heavily in order to force it to curtail operations, the writer is inclined to believe that the rates for taxation of gasoline should not be raised further. Four years ago, when the 2c. and the 1c. rates were most common, he predicted that the most common gasoline tax rate would be 3c. or perhaps 4c. a gallon.[1] Today the 4c. rate has more adherents than any other rate. It is not unreasonable to believe that a 5c. tax will prove to be the most common. The question of the rate in individual states, however, must depend upon the will of the people. If roads are few, the population may be prepared to pay high taxes in order to secure the desired transportation facilities. If the road system is well developed, a lower tax may care for adequate maintenance and renewals.

Closely related to the public sentiment in favor of

[1] E. P. Learned, State Gasoline Taxes, Humanistic Studies, Vol. III, No. 4, University of Kansas, Lawrence, p. 24.

Minnesota—One-course concrete pavement in Winona County, typical of the state trunk road system

South Carolina—Mixing re-treatment in place, using crushed granite and cut-back asphalt

gasoline taxes and a political factor in the question of high tax rates is the problem of the use of gasoline tax revenues. On this question no categorical answer can be given. The conditions within a given state are bound to modify any general rules enunciated. Yet the higher the gasoline tax rate the more likely is diversion.

Tax Diversion and Distribution

When the tax rates were much lower than they are today and primary systems of roads were not well developed, the major share of the revenue was properly spent by many states on state highway systems. It seems wise to complete systems of primary roads from gasoline taxes before distributing large proportions of the revenue to the counties for secondary and tertiary road systems. The gasoline tax, moreover, should be high enough to support the maintenance of the primary system and to make provision for renewals in that system. It is recognized that a real highway development program has in the past and must in the future extend over a period of years. Time and money are required to carry out well-conceived plans for highways.

Massachusetts—Whitcomb summit on the Mohawk Trail. Bituminous macadam with seal coat omitted to give non-skid surface

The argument for county and city participation in revenue from state gasoline taxes is a strong one. If a gasoline tax is an equitable method for measuring the benefit of state roads, it should be equally equitable as a measure of the use of county roads. If this argument be admitted, it follows that the towns and counties should be allowed to raise money for roads and streets by means of gasoline taxes. But to give these political units the power or right to levy such taxes might involve constitutional questions. More important, however, is the confusion which would exist when within a state there are sundry gasoline tax laws. Attempts at consumer evasion would be common. Oil companies, moreover, would have to incur extra accounting expense. When a state has a high rate of gasoline taxation, it seems more logical for the state to share a portion of its gasoline tax revenues with its political subdivisions.

A number of different methods may be followed for distribution of a share of state gasoline tax funds. One method is to return to the local government divisions amounts in proportion to the amounts collected in the county. This method is an easy one to administer and it insures that those who pay the tax within the district will have some of it returned to their district. Another method is to use the population within a district as a basis of distribution. Where the population is dense, there are usually more roads to be maintained. Some states use the number of registered motor vehicles in each county as a basis of distribution. Road mileage bases are used in other cases. An equal disbursement to each county is hardly a satisfactory arrangement, though sometimes it is politically all that can be accomplished. Theoretically, a combination on the basis of area, registration of motor vehicles and mileage of improved roads for the local government division is commendable. It places a great deal of weight on the requirements for maintenance. Yet in the area factor the large county, oftentimes not wealthy but with a vast system of roads to maintain and build, is protected. In practice, some more simple formula often accomplishes the same equitable result. The more simple the method the better it is. A final answer on the method of distribution cannot be given. The conditions within a state must govern the policy of the state.

But more important than the method of distribution to the local subdivision is the manner in which the money is spent. Here engineers in their professional capacity have an opportunity to see that the people get value received. Likewise they must use their influence as members of the body politic to see that the money is not distributed in such small driblets that it is used ineffectively. Distribution of gasoline tax funds to a political unit such as a township (to be spent under the supervision of the overseers of the township) does not seem commendable. The county unit with the supervision of the county engineer on maintenance expenditures seems more desirable. Oftentimes, moreover, it is desirable to have capital expenditures for new county roads

Nebraska—Oil process gravel road typical of 4,500 miles of such roads in the state: 560 miles added in 1929

Louisiana—Surface treatment for gravel roads, a tar primer followed by high-penetration asphalt and slag chips

subject to the approval of a state highway department. This will insure non-political and wise expenditure, because the highway department will ordinarily have more capable and efficient engineers than the counties. The success of the tax depends very largely on the distribution of the proceeds. Funds secured through gasoline taxation should not be used for general state purposes, but only for road purposes.

Attitude of Oil Producers

This survey of gasoline taxes would not be complete without a consideration of the point of view of oil companies whose product is subject to the sales tax. They are naturally the chief opponents of the tax. It is desirable to review their position to determine whether the previous conclusions developed from the user's point of view require modification.

The real objection of oil companies to gasoline taxation centers about two things. First, the industry fears unfair taxation. Almost any tax would be opposed by the industry on the general principle that if the tax were successful it would prove to be the entering wedge for further taxes on the industry. The second objection has to do with the rate of taxation. Some writers in oil journals, for example, maintain that the recent depression in the oil industry was partly caused by the heavy burden of gasoline taxes on the industry. The burden of the argument of some in the industry is as follows: During the past few years an ever-increasing supply of oil and gasoline has been produced and thrown upon the market. Oil men in their anxiety to move stocks have depressed prices to a point where there is no room for both the tax and profit, and since the tax must be paid profits have suffered. Under these conditions the demand for gasoline has more to do with fixing the price than the forces of supply. The writers assert that, had there been no tax on gasoline last year, a considerable portion of the $250,000,000 paid to the states in the form of these taxes would have been spent for gasoline and the industry would have been better off.

The argument of those in the oil industry cannot be granted without question. The social income being limited as it is, it is true that if $250,000,000 is paid in gasoline taxes it cannot be used to buy gasoline. But it does not follow that gasoline would have been purchased with that amount of money had no gasoline taxes been levied. As was pointed out earlier, the demand for gasoline is relatively inelastic. The people who drive cars will use about the same amount of gasoline from year to year regardless of the price, if the price does not fluctuate within too wide range. By paying gasoline taxes they may have had a few less pennies for the theater or for books, but they have continued to buy as much gasoline as if there had been no tax. As a matter of fact, it is not improbable that the increased consumption of gasoline per car during recent years has been encouraged by the good roads created by the gasoline tax.

The real difficulty of the oil industry does not lie in the gasoline tax, but in the failure of the industry to keep production in line with demand at profitable levels. Indeed, the oil industry has been fortunate in recent years in having an expansible market. Whereas the demands of individual customers have been inelastic and therefore would not have taken the great increases in supply at even present price levels, the oil companies have gained the present levels from the fact that the number of cars and trucks in use and on the road has been increasing year by year. This increase in the breadth of the market has enabled the oil companies to secure better prices for increased supplies than they would have received had it not existed.

Though it does not seem that the oil industry has been seriously harmed by gasoline taxes as yet, still higher rates, if high enough to curtail demand substantially, might well reduce volume which could not be entirely offset by higher profit margins, in which case, of course, the aggregate profits of the industry would suffer substantially. The industry already has widely fluctuating profit margins on account of the manner in which tremendous supplies of oil suddenly appear in the market and have to be liquidated at less than a normal cost of production. Even though the industry's version of its trouble is not accepted, still it seems that marked upward revisions in gasoline tax rates might modify the situation so that the oil companies would find conditions somewhat more disconcerting than they now are.

Warning for the Future

What then can be said about the future of gasoline taxes, whether judged from the point of view of producers or consumers of gasoline?

The gasoline tax is patently here to stay. It has been an effective and a relatively painless means of raising revenue. The fact that it is a sales tax on a commodity of inelastic demand makes it seem likely that the tax can be a fixture in our state revenue machinery. But there are always sleeping political dogs. Unreasonable rates and dissipated expenditures will wake these dogs sooner than anything else.

Idaho—Emulsified asphalt construction near Lewiston. Mixing the oiled surfacing material before spreading

New Hampshire—The state added 55 miles of this type of two-strip concrete pavement during the past year

Born in 1878, John Edwin Brindley was graduated from the University of Wisconsin 1902 and joined the faculty of Iowa State College in 1907, becoming professor of economic science in 1917. He has acted successively as tax expert of the Iowa State Code Commission and the Joint Legislative Tax Commission

Highway Financing by Special Assessment

By John E. Brindley

Professor of Economics, Iowa State College, Ames, Iowa

Special assessments, employed only in a small way for financing rural roads, are the principal means of raising funds for the connecting links of these roads through villages and cities. Their history, legal basis, fiscal status and methods of apportionment are epitomized in this article. The question of benefits and the devices for spreading assessments according to benefits are complex and have been scarcely more than enumerated in the limited space commanded by the author. Indeed, the whole subject is special and complex. To its discussion Professor Brindley brings the accumulated experience of an expert in tax legislation and the broad knowledge of a teacher in economics. His conclusions therefore carry exceptional authority.

SPECIAL assessments assume considerable financial importance in the construction of public highways, especially within the boundaries of towns and cities, and are distinguished from taxes by important differences of a legal and economic character. They therefore command consideration in a review of practice and possibilities in providing funds for public roads.

Definition and Origin

Special assessments represent a general form of public revenue co-ordinate with revenue from the public domain, public industries, fees and taxes. The term is so complex in its manifold applications as to be impossible of exact definition. Exceptions would need to be made at almost every general point.

The definition given by the Bureau of the Census, somewhat abbreviated and with slight modifications, will be reasonably satisfactory. Special assessments are compulsory contributions levied under the taxing or police power, or the power of eminent domain, to defray the costs of specific public improvements or public services undertaken primarily in the interest of the public, and apportioned according to the assumed benefits to the property affected by the improvements or the assumed benefits to individuals or corporations by reason of the services performed. In a word, the definition includes four distinct elements as follows: compulsory contribution, cost of specific public improvements or public services, the public interest and the theory of special assumed benefits to property or individuals. Of these elements, the first three apply with equal force to taxes, and the fourth in a large measure to certain special taxes.

Origin and Development—Special assessments in one form or another have been traced back to 1427 in England, 1672 in France, 1691 in New York, 1807 in Belgium and 1875 in Prussia. In 1427 a number of acts were passed in England creating commissions charged with the construction and repair of walks, ditches, gutters, sewers, bridge causeways and trenches which had been impaired by the sea. The great fire in London in 1666 required the rebuilding of a large part of the city, and the act of 1667, which became a model for the law of the Province of New York in 1691, empowered the Corporation of London to appoint certain persons with authority to pave the streets and to make other municipal improvements, and impose any reasonable tax upon all houses within the city in proportion to the benefits received. Special-assessment districts were created with much care on the theory of benefits received instead of regarding the entire city as a unit. This legislation, supplemented by a definite plan of administration, laid the foundation for the modern system of special assessments.

An act for regulating the building of streets, lanes, wharves, docks and alleys in the city of New York in

Kansas—Concrete highway east of Topeka. How pavement is transforming old dirt roads

Delaware—Dual highway formed by laying new 20-ft. concrete pavement 50 ft. east of the old pavement

1691 imposed a reasonable tax upon all houses within said city in proportion to the benefits received; and in default of payment of the amount charged in each case it was made lawful for the proper city authorities to levy the sum so assessed by distress and sale of the goods of the parties chargeable therewith. Following the Revolutionary War an act was passed in 1787 differing from the law of 1691 in several particulars, the essential difference being a general theory of benefits outlined in the statute under which the mayor and aldermen were given wide discretion as to the method of fixing the assessment of benefits on recommendation of "five sufficient and disinterested freeholders for every such purpose." While the mayor and aldermen were somewhat reluctant to exercise the large general powers granted under this act, the authority was reaffirmed and somewhat expanded by the legislature.

By 1813 the legislature authorized the method of special assessment in Albany, Hudson and Schenectady. The distinctions between special assessments and ordinary taxes had been recognized by the courts of New York at the same date, and by 1851 the legal and constitutional basis of special assessments had been finally settled, it being held that assessments of this character are levied under the taxing power of the state and are not, therefore, limited to the police power or that of eminent domain. This method of financing spread rapidly after 1851, and by 1893 forty states and two territories had accepted the doctrine of special assessments.

Legal and Fiscal Status

Special assessments may be levied under the police power, the power of eminent domain and the taxing power of the state. Historically the police power, being very extensive and elastic, was employed at a very early date as a justification for special assessments, especially in cases involving regulations to promote public safety or to protect the public health. There are many court decisions ordering sidewalks built and the costs charged to the property owner, which is clearly a police regulation. Sewer assessments, being the outcome of a sanitary or health regulation, can obviously be included under the police power, and the same is true in the case of drainage laws which are enacted for the double purpose of reclaiming land and as a public health regulation. It should be observed, however, that when special assessments are based on the police power, the doctrine of special benefits received does not necessarily apply, the actual cost being frequently in excess of the direct benefit to the lot owner, which is not the case when said levies are authorized under the taxing power of the state.

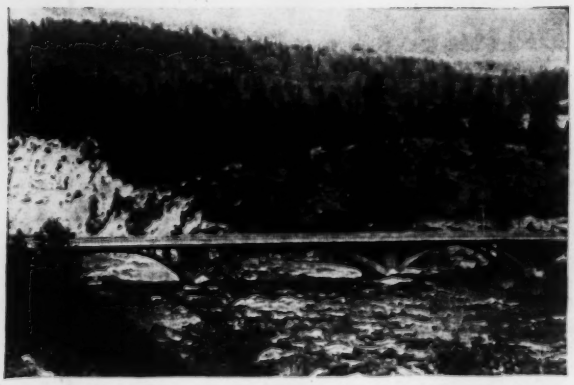
By eminent domain we mean the right of the state to appropriate for its sovereign purpose the property of an individual on condition of the payment of a just compensation. Under the taxing power, property may also be appropriated by the state, but obviously no requirement is made in this case for the payment of a just compensation. The opening up of new streets or roads and the widening of old ones frequently requiring the destruction of valuable buildings requires the taking of private property for public purposes, which may be done under the right of eminent domain by the payment of a fair compensation. However, as early as 1667 in London it was recognized that the state had a right in such cases to a counterclaim by virtue of the increase of value of any ground that might be left on each side of the new street or road. This increase of value often equals or in fact greatly exceeds the damage resulting from the taking of private property for a given public improvement.

Be all this as it may, it would be difficult to justify the millions of dollars that have been expended in recent years for the improvement of public highways either as a police measure or by any application of the right of eminent domain. No problem of health, morals or safety is involved, and only in certain cases such as relocating is private property taken to make possible a given highway improvement.

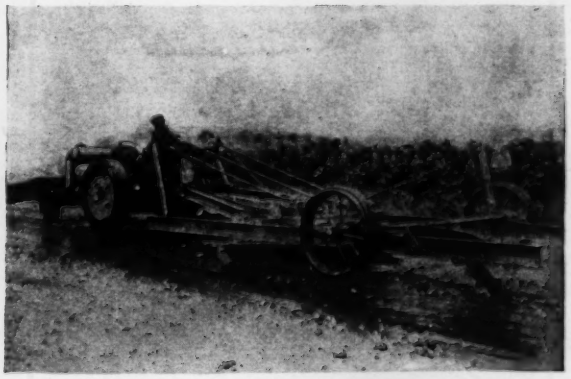
Finally, special assessments in the large majority of cases under present conditions are authorized under the general taxing power of the state primarily for the reason that they are compulsory contributions imposed for a distinctly public purpose. The legal questions involved were put at rest in a comprehensive opinion in New York in 1851. On the other hand, however, it should be observed that special assessments are not taxes from many very important standpoints. Exemption from taxation under many different laws does not exempt from special assessments for public improvements, nor do constitutional and legislative tax limitations apply in such cases. The very important constitutional provision relating to equality and uniformity of taxation does not apply to special assessments. Finally, the term "special" in many court decisions applies only to special taxes for roads, schools, bridges and parks that are levied in the same manner as general taxes.

Fiscal Status

The fiscal aspects of special assessments may be considered briefly from the point of view of special benefits, relation to special taxes, how to circumvent statutory and constitutional tax and debt limitations, the theory of



Washington—Dryden bridge over the Wenatchee River. The bridge has a 24-ft. roadway with 5-ft. sidewalks



Indiana—Oiled gravel road work. Scraping loose gravel from the edges back over newly oiled surface

general benefits and the theories of faculty, proportionality and progressivity of taxation.

Reference has already been made to the fact that special assessments are authorized under the taxing power on the well-known theory of special benefits received. A word should be said at this point regarding this theory and the fact of certain special taxes. Seligman in his "Essays on Taxation" says: "The test of the special assessment is measurable special benefit; the test of the special tax is special taxable capacity or faculty." On the one hand the test of certain special taxes as well as special assessments is far more a question of benefits received than one of faculty or ability to pay; and on the other, we can measure benefits in either case with only relative accuracy. The plain facts are that the same classes of improvements are financed in our own country out of special taxes or special assessments depending primarily on legal and constitutional rather than economic considerations, and in Europe, where such considerations do not exist, there is little necessity for special assessments, and quite obviously almost nothing is said on the subject by foreign writers. Where a city or other local community can levy special taxes largely as is well known on the theory of special benefits without being troubled with legal restrictions or a rigid written constitution, why go to the added labor of the somewhat more cumbersome method of special assessments?

The same writer also states that another difference between a special tax and a special assessment is that the latter is always proportional, whereas the former may be either proportional or progressive. It is true that special assessments are proportional to benefits received, the rates being the same where the benefits are the same. Exactly similar reasoning applies in the case of general or special taxes assumed to be based on faculty or ability to pay, the rates being the same where the faculty is the same. Where the faculty increases more rapidly than income, the rates become progressive, as in the income tax. Where the benefits received become greater close to a given improvement, the special assessment rates become higher, or in other words progressive. If we move in the opposite direction from the improvement, the rate is retrogressive.

Whether rates are retrogressive, progressive or proportional depends on the point of view of the observer, whether he is thinking of decreasing benefits, increasing benefits or the same benefits. Innumerable examples might be given of this principle. The Black Hawk County (Iowa) paving district and the Dayton View Park assessment in the city of Dayton, Ohio, will serve as typical illustrations. The truth is that special assessments are far better adapted to the principle of progressivity than any form of special or general taxation.

When a city in particular finds that it has reached the limit both of regular or special taxes and debts, the courts have developed the very helpful legal doctrine that special assessments are not taxes under the meaning and intent of equality and uniformity clauses of the Constitution or other sections fixing tax or debt limitations. Special assessments, therefore, become a very practical method of providing funds for desired, perhaps necessary, improvements, which otherwise could not be financed. In the absence of such restrictions America as well as Europe would no doubt have financed practically all such improvements by the method of special taxes. In a word, the supreme test of special assessments would appear to be largely in the field of constitutional and statutory law rather than economics. This, by the way, is a subject deserving of far more careful research on the part of American publicists.

While faculty or ability to pay requires that special assessments be limited by statute to some per cent, usually less than 50 per cent, of the value of the land when the same are based on the taxing power and the principle of proportionality applies where benefits are the same, the law of progressivity would appear to be the rule in the case of special assessments.

Methods of Apportionment

It is one thing to say that cost should be assessed according to benefits and quite another to spread the assessment in strict conformity with that principle. A few general economic and administrative principles, however, have been worked out with a certain mathematical technique, which are very helpful in the task of apportioning special benefits. Bearing in mind that the apportionment of costs should have some reference to the value of property, particularly the increment of value resulting from a given improvement, which may require some time to develop, there are four principles of apportionment—the front-foot rule, area, zone and area, benefit-factor method, and various combinations of these. In recent years the tendency has been to encourage the use of some combination of systems.

Where lots are laid at right angles and extend back about the same distance, the front-foot rule is frequently adopted for such improvements as paving, curbing and sidewalks. For lots not abutting or of irregular shape, this rule cannot measure benefits and should not be applied. The law generally requires that the benefited

South Carolina—Light mixed-in-place retreatment using tar and crushed granite, Anderson County

Wisconsin—First superhighway in the state. Second step will be the addition of 20-ft. strips on the inside

area may not extend more than half way to the next parallel street or not to exceed some statutory distance, such as 300 ft., from the improvement. This method of assessment is not adapted to projects that include the widening of streets, nor to projects involving the opening of new streets.

The area rule should be taken into account along with other factors, but as a sole method of assessing costs it should be applied in only a small proportion of the districts met with in practice. In cases where the lots involved are laid out in equal frontage and the depths vary, the area method of distributing benefits tends to be equitable.

In order to take into account the diminishing benefits of parcels of land that do not abut on the improvement and at the same time recognize the variation of benefits with area, the zone-and-area method of apportioning costs is employed both for street improvements and for suburban roads. A certain percentage of cost is allocated to each zone, the amount being higher close to the improvement. The assessor is the judge of the percentage to be assessed on each zone, but as a rule it is generally assumed that the benefits diminish as the square or cube of the distance. In a word, the principle of progressivity, as explained above, applies as between the zones and also as a general rule within a given zone.

Texas—Newly completed asphalt macadam pavement on a base of sledged rock

Special assessments are certainly not at present an important method of highway finance in the rural districts, and in the writer's opinion are becoming less important. For the entire United States, special assessments for operation and maintenance in 1926 amounted to only $926,372, and special assessments and special charges for outlays the relatively small sum of $27,145,271. For 1927 amounts for the same purposes were $1,202,135 and $25,876,050 respectively. In 1927 only six states reported receipts from special assessments for operation and maintenance, four for drainage and fire patrol and only two, Massachusetts and Virginia, for roads. It would also appear from the report that the $25,876,050 of special assessments and special charges for outlays includes special taxes as herein defined as well.

The Bureau of the Census for 1922 gives the revenue from special assessments for all purposes as follows:

Aggregate	$205,293,000
States	9,410,000
Counties	19,475,000
Incorporated places	149,459,000
Specified civil divisions	26,949,000

The data for states include special assessments only, not other special charges as noted above. It is obvious that special assessments are a relatively important source of revenue only in incorporated places, where they are so commonly used for various street improvements. Counties frequently employ this form of revenue for drainage as well as for road purposes. While we are not able to learn from census data what part of this special class of public revenue is used for rural roads, it may be safely assumed that the large, and no doubt includes amount is not relatively a substantial part of the $26,949,000 indicated for specified civil divisions. For the country at large and for all purposes, special assessments produce 4.9 per cent of state and local revenue and 1.1 per cent of revenue for the use of state governments.

The most important conclusion the writer would suggest is that the levy of additional special contributions on property even under the plea of special benefits received is of doubtful wisdom as a general policy of highway finance. The construction and maintenance of the main highways largely out of gasoline and motor-vehicle taxes and other special forms of income and business taxation would appear to be the trend of the times.

Property in the form of general and special taxes should bear and is bearing a less and less part of the burden of highway finance. Even under a rigid tax limit policy, the law generally permits rather substantial levies for road and bridge purposes, adequate from the point of view of a well-balanced plan of public finance. Where such is not the case, for legal and constitutional reasons noted above, special assessments are indicated. In the opinion of the writer, however, it should be the exception and not the rule in the field of rural highway finance.

Rhode Island—Existing reinforced-concrete pavement widened by adding 10-ft. strips on each side

Indiana—Concrete pavement on the Dunes highway with 4-ft. bituminous retread shoulders

Thomas Radford Agg, professor of highway engineering in Iowa State College since 1913, was born in 1878 and was graduated from Iowa State College in 1905. He is consulting engineer of the Iowa Highway Commission and a close student of road economics

Federal Aid for Roads

Why Past Accomplishment Urges Its Continuance

By Thomas R. Agg

Professor of Highway Engineering, Iowa State College, Ames, Iowa

What has federal aid for road building accomplished? How far should it continue? The author's answer to these questions is that federal aid has accomplished great things, and that its powerful influence on road building is needed as much as ever. It should be continued not because the money pays for such a vast mileage of improved road, but because it assures high standards of administration and engineering and efficient financing. Federal aid does not translate into many physical miles of road, but it does translate into an impelling force for systematic financing, careful budgeting, and good construction and maintenance. Contemplated by itself, the total of federal aid is large—$840,000,000 since 1916—but it is less than one year's expenditures on state roads by the 48 states. The prime value of Professor Agg's discussion lies in the proof that other values than money have come to the states as a result of aid from the federal government.

FEDERAL aid for highways as it is now functioning was established as a definite national policy by an appropriation of $75,000,000 made July 11, 1916, to be expended over a period of five years in the construction of roads in co-operation with the states in which the roads were located. The law provided that before any work was done in any state the legislature of that state must formally accept the provisions of the federal statute. The act also provided a basis of distribution of federal appropriations to the states and prescribed a method of administration.

Inasmuch as the first road inquiries, which were authorized in 1893, had in view the betterment of agricultural conditions in the nation, it was quite natural that the appropriations should be made to the Department of Agriculture. Once the Office of Public Roads was established in that department and so long as it continued to function satisfactorily there was no reason to transfer it to another department. As the years have passed, the old Office of Public Roads has become the Bureau of Public Roads, with far-reaching responsibility and authority in connection with the federal-aid system of highways.

In the period following the act of 1916, the Bureau of Public Roads had to readjust its organization and policies entirely in order to meet its new responsibilities. Fortunately it was able to command able leadership and to meet the new situation in a broad and statesmanlike manner. In spite of the limitations imposed upon it by a multiplicity of laws, fiscal regulations and official red tape, it has managed to assume and maintain leadership in the field of highway administration; this despite the inadequate salaries it has been able to offer to its personnel during most of the period of its existence.

Basis of Allotment

The basis of allotment of federal aid to the states has not changed greatly since the first act was passed. In 1929 the allotment of one-third of each year's appropriation was based on the ratio of the area of a state to

Oklahoma—Gravel surfaced road in Cherokee County, notable for small amount of crown

Vermont—New concrete pavement on the Green Mountain highway south of Bennington

the total area of the United States, one-third was allotted on the basis of the ratio of the population of a state to the total population of the United States, and one-third was allotted on the basis of the mileage of star and rural delivery mail routes in the state to the total of such routes in the United States.

It was further provided that the federal government should not pay to exceed one-half the cost of any road and in no case to exceed $15,000 per mile. An exception to this distribution was made in those states in which there is a large amount of public land that does not contribute in state taxes but must be traversed by the main roads. In these states a special allotment scheme has been devised to enable them to make progress.

The Fiscal Picture

Statistics are dry reading, but the following summary of the physical accomplishments under federal aid is illuminating and suggestive:

Total appropriations for federal aid to Sept. 30, 1929	$840,000,000
Total miles of completed road upon which federal aid has been applied	79,494
Estimated total cost of federal-aid roads under construction	$256,740,729
Total miles of federal-aid road under construction or covered by definite project agreements	12,479
Balance available for allocation to projects	$36,031,807

Other Accomplishments

While the statistical summary indicates the tangible results of the operation of federal aid, there are other accomplishments of far-reaching importance that have resulted directly from federal aid. These byproducts should be taken into account in any evaluation of the influence of federal aid for highways.

Establishment of United States Highways—For several years prior to 1925 there had been a growing need to devise some means of insuring that the federal-aid roads that were being built in scattered units all over the country would finally connect up into a real national system. There was no way to accomplish this except through the voluntary co-operation of all the states. Fortunately, most of the state highway departments recognized the situation and favored a move to bring about the desired result.

In 1925 there was appointed a joint committee composed of representatives of the states and the federal government, whose function it was to propose a system of national highways. After many months of effort such a system was proposed and approved by all concerned. As a result, there is rapidly developing a real system of national roads marked with the familiar shield and recognized by travelers as roads that may be expected to be well kept at all times.

The concentration of funds on these roads has insured their rapid improvement and has given the traveling public an impressive example of what can be accomplished by concerted effort. The good will thus engendered has been an important factor in the continued popular support of state construction programs.

Engineering—At the beginning of federal aid some states had well-manned and competent highway departments, some had departments that were more or less lethargic, and many had none at all or at least none with any real authority. Under such conditions one could scarcely expect that standards of construction would be alike in all the states, nor could one expect equal excellence of engineering work in all the states. Moreover, the highway departments were the victims of our political system, and might be doing excellent work one year and poor work the next because of changes in personnel brought about by the accidents of politics.

Since federal aid has been in effect, it has been necessary for each state that wishes to accept its share of federal aid to maintain certain standards of engineering and construction. Moreover, the Association of State Highway Officials has become a powerful influence in the highway field, and its committees have done splendid work in connection with the standardization of highway engineering. Without the common interest that has arisen because of federal aid, it is doubtful if the states would ever have found a common ground upon which to meet to discuss the problems of road construction.

Financial—While the actual financial contribution in the form of federal aid has been but a fraction of the sums expended for highways, it has meant many additional miles of road. The fact that the United States highways are the heavily traveled roads has tended to relieve the local units of government of the more expensive projects and therefore eased their financial problem somewhat. The knowledge that federal aid had to be met year after year has caused the states to adopt orderly methods of finance and real financial planning.

Research—The Bureau of Public Roads has for many years been engaged in highway research. Upon the advent of federal aid the bureau found itself confronted with many new problems and the need for considerably augmenting its research program. The state highway departments have also entered the research field, and

Minnesota—Concrete pavement with a gutter to prevent wash of the shoulder on high fill

Illinois—Concrete pavement 18 ft. wide on a graded roadway 40 ft. wide

many excellent projects have been completed and others are in progress. Some of these have been carried out by co-operation between the Bureau of Public Roads and state highway departments. In addition, the engineering experiment stations connected with the land-grant colleges have done yeoman service in the field of highway research, and have at this time many projects under way.

The latest report of the committee on research of the Association of State Highway Officials lists more than 350 projects now under way, being carried out either by highway departments or by highway departments and co-operating experiment stations. While not all of these projects are of national importance, there are in the list many of great general interest.

The Highway Research Board developed out of a need to stimulate and correlate research work in this field and after several years of floundering in an attempt to find its place in the scheme of things (during which time it gathered together many valuable data, however) is now finding itself and bids fair to become an important factor in the highway research field.

Recently the American Road Builders Association has undertaken some research projects, and since it has funds at its disposal it may be able to contribute to the store of information on highway problems, particularly those relating to equipment and construction methods.

It has come to be recognized that scientific research is fundamental to progress in any field, and the fact that so great an interest in highway research has followed the adoption of federal aid is a hopeful sign. It may be predicted that continued progress in the art of road building is assured so long as the interest and participation in research continues.

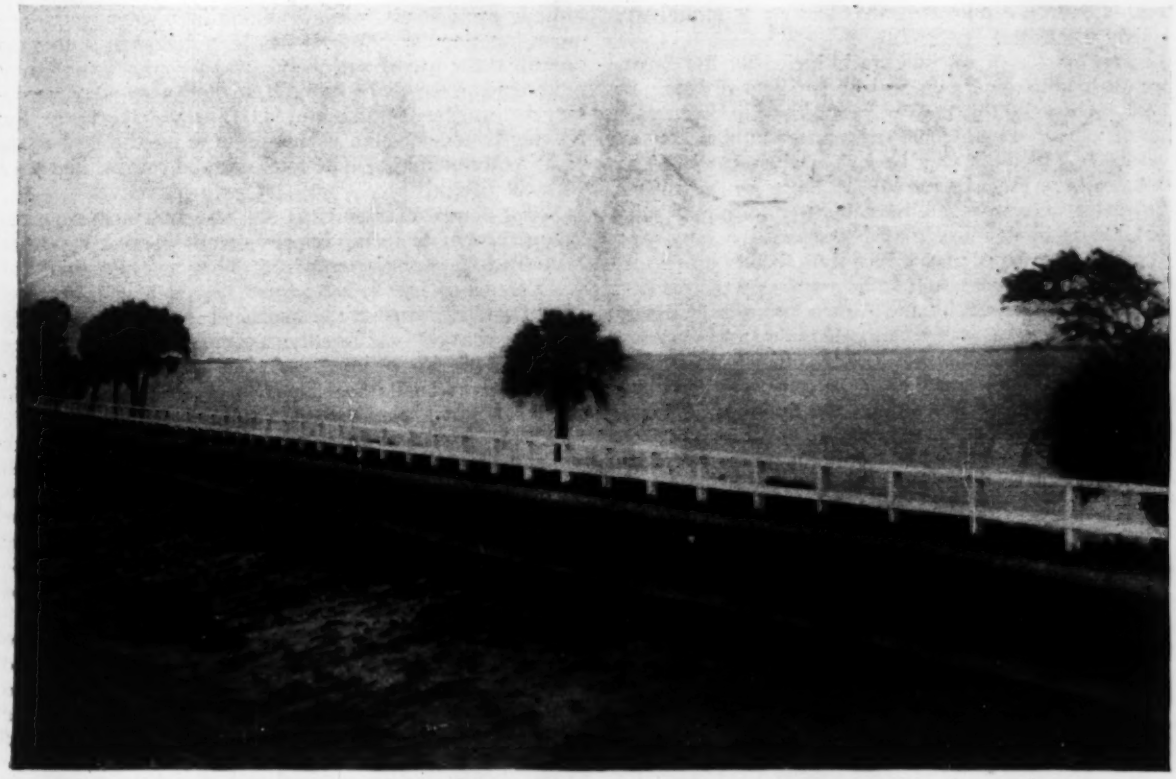
In general, knowledge is being advanced and very much of the credit is due to the labors of the Bureau of Public Roads in its efforts along educational lines and in the administration of federal aid, and to the painstaking efforts of the better organized highway departments.

What of the Future?

Federal aid for highways should continue because of its stabilizing influence on highway administration, and this is recognized quite generally by all who have come into contact with its operation. What is more important still, it should continue for financial reasons and at a greatly increased annual rate. To a great extent the taxes that build up federal funds are obtained from sources that reflect quite accurately the condition of business throughout the nation. One factor in stimulating business is good transportation, of which the highways form a link.

It now appears that exclusive express highways of special design to permit uninterrupted fast traffic are needed in certain areas. These should be laid out with a view to future connections with similar highways as the need arises. The projects are too vast and too complicated for state financing, and there should be special Congressional appropriations in aid of these projects in addition to the increased federal aid for the already established United States highways.

We have only made a good beginning on the highway problem in the United States. The work must go along at an accelerated pace for years to come, and the great stabilizing and correlating factor in the problem is federal aid. Without detracting in the least from the splendid work the states are doing, it is only fair to admit that the whole program of highway construction in the United States is interwoven with policies, standards and financial considerations that are the outgrowth of federal aid.



Florida—Concrete pavement along the Indian River in Brevard County

As engineer of Allegheny County, embracing the metropolitan district of Pittsburgh, and later as chief engineer of the Pennsylvania State Highway Department, Samuel Eckels has had direct contact for years with problems of county and township highway financing

County and Township Financing

A Problem in Tax Equalization

By Samuel Eckels

Chief Engineer, Pennsylvania Department of Highways, Harrisburg, Pa.

Federal aid, bond issues and gasoline taxes for national and state highway systems are the prominent questions in the road field. But county and township road-financing problems are growing in importance so rapidly that they may no longer be overlooked. These smaller political subdivisions control nine-tenths of the country's road mileage; if their financing is not wisely studied, it is likely to become a threat to progress of the state and national system.

Already there are movements in Congress, in state legislatures and in the propaganda of farm and other organizations tending to divert effort from the completion of main systems of highways to the wholesale improvement of local and branch roads. The threat gains strength by reason of the preponderant mileage of the county and the township roads. Mr. Eckels' discussion therefore has more fundamental importance than might be gathered from its sober outline of highway financing by counties and townships. Outstanding in this discussion is the doctrine that financing must come from some plan of tax equalization which will lend to the smaller political units the strength of the larger units.

REVENUES for county and township road improvements are derived from (1) direct tax, (2) bonds, (3) special assessments, (4) state aid, (5) special aid, (6) state reward, (7) county aid and (8) motor revenue.

These methods are used singly and in various combinations in different states and sections of the country. Possibly other sources of revenue are used in a minor degree, but those enumerated are most common and will be briefly discussed.

Direct Tax—A direct mileage is levied by the supervisors or commissioners on real or personal property or on both. Uusually this does not exceed 10 mills on each dollar of valuation. In some cases an additional amount not to exceed 10 mills may be levied when approved by the local court. Also in addition to these levies, when it is shown to the court that the debts of the municipality exceed the amount which may be collected in any year by taxation, the court may direct the officials by special taxation to collect an amount sufficient to pay their debts.

The funds obtained by the direct tax are generally applied to the routine maintenance or minor improvement of the local roads. This revenue, if sufficient, may also be used for the construction of the more costly or so-called higher types of paving and the building of stone, concrete or steel bridges. In many townships, however, the tax duplicate is so small that only the most imperative maintenance can be done and all improvements must be financed by other methods. As an example, the poorest township in Pennsylvania has an assessed valuation of $21,643 and 21.5 miles of road. A tax of 20 mills yields $432.86, or $20.13 a mile. Many other townships in the mountain region of the state have approximately the same conditions. In order to carry on the least possible work on the roads that will enable vehicles to pass over them with safety, tax rates of 20 mills are common and a maximum exists in one case of 32 mills. It will be seen that such rates are excessive and oppressive; road construction becomes impracticable on such resources.

Bonds—Where larger funds are required for financing road construction than can be secured by a direct tax, it has been common practice to issue bonds. These bonds may be short-term, long-term or serial. Some states and townships are prohibited by law from issuing bonds, but counties generally enjoy the privilege. Bonds constitute a legitimate and proper means of financing improvements provided their life is well within the useful life of the improvement.

Long-term bonds, while common in former years, are much less popular now. It has been found in numerous cases that the life of such bonds was too great, and heavy replacements involving capital expenditures were necessary before the bonds matured. The yearly charge for retiring bonds does not decrease much for those of a life of 25 years or more. The total cost, of course, increases with the life.

Serial bonds offer perhaps the best and most economical method of financing improvements where a bond life of five to 25 years is required. They are also used for short terms of five to ten years. Serial bonds offer the advantage of retiring the principal and thus reducing interest charges as rapidly as current revenues are accumulated.

Short-term bonds are largely used for financing improvements of a semi-durable nature where the bond life does not exceed five to eight years. One of the counties in Pennsylvania is issuing such bonds as they are needed to finance county aid to its townships. The aid is given for the grading and drainage structures on which the townships are placing low-cost surfaces. A properly graded and drained subgrade, if developed with suitable alignment and gradients, is a durable improvement and should be a prerequisite for any surface.

Special Assessments—Special assessments are used to a limited extent in county and township work for road purposes and for sidewalks, sewers, water supply and lights. The assessment may be on the basis of linear front footage owned, on a definite zone or on a scale of varying distance from the line of improvement. The front-footage method may result in large inequalities of

assessment unless a difference is made between vacant areas and areas improved with buildings. The method of assessment on basis of distance from improvement may lead also to unfair conditions, as property not adjacent to the improvement may be assessed for benefits, although such property may outlet entirely on another road.

State Aid—Extending aid to the counties and townships by the state has been a popular practice during the preceding quarter of a century. The state contributes from one-third to three-fourths of the cost of the road improvement, and the county and township or townships through which the road passes supply the remainder of the cost. It is applied to roads either on or off the state highway system, but is generally restricted to the roads which carry a large amount of traffic or are of major local importance. State aid, while useful, has been too much restricted by lack of funds, by type of construction required and by location of roads to be fully useful to the rural communities. Its merit is in the stimulus given to construction of important secondary roads.

Special Aid—A variation of state aid consists of restricting to construction of unimproved roads on the state system the funds allocated by the state to the counties. The counties contribute usually in the same proportion as required for state aid. Special aid is of greatest usefulness to the wealthier counties, which can easily supply their share of the cost. It fails to give relief to the sections of country which have a low valuation.

State Reward—A second variation of state aid is state reward. As this system has been developed over a period of ten years and is now being successfully administered, it will be described more in detail.

Applications for road, bridge or culvert construction are made by the supervisors of the various townships to the state department of highways. The applications are placed on file and action is taken on them in the order of filing in each county. Whenever state-reward funds are appropriated by the legislature, action is taken and an agreement is issued to the local authorities. This authorizes them to proceed with the work, either with their own forces or by contract. The agreement stipulates the maximum amount of reward payable on completion of the work. The amount varies from 75 per cent of the cost not exceeding certain fixed limits, in the case of those townships having an assessed valuation of $20,000 or less a mile, to 50 per cent for those townships having a greater valuation. The township or county or both may contribute the share of cost assigned to the local units.

The specifications for the state-reward roads are less strict for the lower types than the high-type state roads. When satisfactorily completed, the state pays to the township the amount of reward due for the particular class of work. This varies from a minimum of $1,000 for the grading and draining of a 16-ft. road to $9,000 a mile for a concrete, brick or bituminous macadam surface. These amounts are small, but stimulate the improvement of a large mileage of low-cost roads rather than a small mileage of high-cost roads.

County Aid—The county may extend assistance to the townships either in conjunction with state aid and state reward or separately. The money for this purpose may be secured from general county taxation on property or from state motor revenue funds allocated to the county.

Motor Revenue—Placing a tax on gasoline consumed in motor vehicles has been a favorite method of raising funds in recent years. It is now accepted in all the states as an easy method of securing money for road construction and maintenance. This method is not perfect, but is one of the fairest methods yet devised. The tax per gallon varies from a minimum of 2c. to a maximum of 6c. The amount of tax is, of course, in direct proportion to the gas consumed and approximately represents the amount of use of the road by the vehicle.

In addition to the gas tax a vehicle tax is imposed and in many states a driver's license is required. The vehicle tax is probably based on horsepower of motor in a majority of the states. The gas, vehicle and operator's tax comprise the motor revenue. Primarily this fund is used to pay operating expenses of the state department of highways and the cost of construction and maintenance of the roads on the state highway system. Secondarily it is used to pay state aid, special aid and state reward to the counties and townships.

Summary—Much has been written and said on the subject of taxation. Commissions have studied it, but no solution for the complex problems which are encountered has been found. Remedies, of course, have been proposed and have afforded help in some cases, but general relief has not been given. There are certain reasons for this which may not be clear to the general public.

County and township road work is essentially a rural problem which is of most immediate concern to the farmers. The American farmer is independent in thought and action and is influenced by his particular environment. He can and does co-operate when appealed to in a manner that indicates an understanding and sympathy with his problems, but asserts his independence when improperly approached. Too often a solution of the tax problem and rural assistance has been proposed by people with little real knowledge of rural conditions. The rural regions must always remain the source of food supplies for those residing in the cities and great centers of population. Roads must therefore be improved so that the farm products can be readily and economically transported to the markets and to give the rural dweller access to the benefits of civilization found in the towns and cities.

It must be recognized that many townships and some counties could do little or no road building if it were necessary to rely on their own resources. Where the taxable property consists of farm land and forests of small value, the revenues are too small to be of much use. Some method of tax equalization is absolutely essential. A proper combination of aid systems seems to offer favorable possibilities.

From an experience of several years in Pennsylvania the combination of state-reward funds appropriated from motor revenues, county aid received from gas tax and direct county tax, and township funds derived from direct tax, is yielding very favorable results. It has taken several years to find the proper balance or percentum of cost to be borne by each unit participating. As indicated elsewhere in this article, it may vary from a 50-50 basis to a 75-18¾-6¼ basis.

By proper co-operation of state, county and township officials it is now possible to work out a satisfactory combination for nearly all situations. Our laws and system of aid and taxation are not perfect, but they have been greatly improved and more satisfactory results are being attained this year than at any time in the previous history of the state. Also, a commission provided at the 1929 session of the legislature is now studying the township laws with a view to revising, amending and codifying them so as to make them of the greatest practical use. We therefore view the present situation with some satisfaction and the future with optimism.

A Symposium on Current Road Progress

Trends in Planning and Construction

Curves and Grades
By J. T. Ellison

Highway Signs, Signals and Lane Marking
By E. W. James

Safety Progress
By Sidney J. Williams

Equipment Invention and Application
By William Ogden

Research and Testing
By R. W. Crum

Shoulder Widths, Construction and Protection
By John D. Waldrop

Pavement and Roadway Widths
By V. R. Burton

Trends in Road Surfaces
By C. N. Conner

AS WE review the last full year of billion-dollar road building what trends in highway improvement are indicated? Is it pointed toward wider, straighter and safer roads, toward better marked and signaled roads and toward more scientifically planned roads constructed with better equipment and materials?

An affirmative answer is indicated by the eight writers, each an authority in his field, whose articles make up the following symposium on highway practices and trends in 1929. It is indicated just as certainly that highway engineering has far to go before it reaches the goal of complete service to traffic.

It is even more certain that standards that have satisfied us in the past cannot be carried over into the future, but that new standards of construction and new conceptions of economy and service must be created. These eight articles are less significant for the facts they present than for the progressive thinking that they indicate.

* * * *

Curves and Grades

By J. T. Ellison

Chief engineer, Minnesota Department of Highways. Promoted after advancing through various positions in the department. Long experience in highway engineering

THE trend is toward much higher standards of highway alignment and grades. This is indicated by the improved practices recommended each year by the committee on road design of the Association of State Highway Officials and adopted as standards by the association. In 1929 these standards were:

1. The maximum degree of curvature for horizontal curves having central angles of 45 deg. or more shall be from 5 deg. to 11 deg., while for curves having smaller central angles the flattest curve feasible, not exceeding 5 deg., shall be used.
2. Horizontal curves in the same direction separated by short tangents, commonly called broken-back curves, shall be eliminated wherever practicable.
3. Slight changes in the direction of alignment (3 deg. or less) shall be made on high points in so far as practicable, instead of in depressions.
4. Horizontal and vertical curves shall be used which will provide a sight distance of at least 500 ft.

At its recent meeting in San Antonio the committee recommended that No. 1 be modified by the following addition: "Abrupt changes in standards of curvature shall be avoided, and progress from a zone where sharp curvature is required to a zone of easy curvature, or vice versa, shall be accomplished by a progressive transition in curvature standard." This modification of the standard previously adopted is particularly pertinent where topographic conditions do not permit full compliance with the standard of curvature recommended.

It also recommended that No. 3 be modified by the addition of the following: "Sharp horizontal curvature (over 3 deg.) shall not be combined with either convex or concave vertical curves where relatively steep grades are involved. On convex vertical curves combined with horizontal curves the latter shall be designed completely to cover or extend beyond the ends of the vertical curve."

As there has been a tendency on the part of some interests to consider grade-crossing eliminations in a class by themselves, the committee on road design is recommending, in connection with grade-crossing elimination, that the maximum grade shall be 5 per cent and that other standards of practice adopted by the association, covering alignment and sight distance, shall apply.

There is a growing trend away from the practice of designing for the maximum amount of horizontal tangent and unbroken tangential grades. Slight changes in alignment with easy curvature which fits the topography are superior to tangent design disregarding topography. Where both ideal grades and alignment cannot be secured, the standard of gradient should be sacrificed in preference to sacrificing standard of alignment.

Where the topography justifies the use of maximum grades, of 6 per cent or more, all of such grades should be compensated on curves up to 1,000-ft. radius, using the following formula, which is similar to that adopted by the California highway department: C (in per cent) $= 12{,}500 \div R$, where C is the correction factor in per cent to be applied to the ruling grade as compensation, and R is the radius of curve. If G is the ruling grade, then $G - (C \times G)$ is the compensated grade.

The compensation provided by the foregoing formula does not include or contemplate any compensation which may be necessary to furnish slack grade for future shortening of the line. Where subsequent improvement in alignment is anticipated, separate and additional compensation must be introduced.

In closing, I wish to show what can be accomplished by careful attention to alignment and grade in the reconstruction of existing highways. During the past working season we have reconstructed, as part of our grading program, highways having an original length of 370.7 miles; the length of the relocated highway as constructed was 329.5 miles, a net saving of 41.2 miles. This relocation also eliminated 236 sharp turns.

Credit must be given to the committee on road design of the American Association of State Highway Officials for the greater part of this article, but I have used their material because of the fact that it in my opinion represents more accurately than anything else the present trend in the location and design of our modern highways.

* * * *

Highway Signs, Signals and Lane Marking

By E. W. James

Chief, division of design, Bureau of Public Roads. Born 1877; Harvard University 1901; Massachusetts Institute of Technology 1905-7. With Bureau of Public Roads since 1913. Previously district engineer, Department of Public Works, Manila.

FOUR years have elapsed since the series of signs and route markers devised by the American Association of State Highway Officials was recognized as standard by all the state highway departments, and a brief summary of progress made in this important phase of the highway safety problem, as canvassed by the Bureau of Public Roads acting as coordinating or central control agency, is of general interest.

The signs are divided into two general classes: first, the standard shield marker, carrying the appropriate highway number, and second, the complete series of caution and warning signs, which includes the railroad crossing and extreme caution "stop" sign. The first class, or shield marker, with its supplementary "turn" indicator or confirmation arrow, is designed primarily for the convenience of the tourist, and obviously its display is restricted to the routes selected by the association to be systematically numbered and known as U. S. highways. In the second class, or caution series, however, the signs are essentially safety devices of great value, and as such can and should be displayed at points of potential hazard, whether on U. S. routes, state highways, local roads or for that matter on city streets.

Standard "stop" sign with reflecting element. Yellow background with black legend and housing for reflector in center third

Standard Shield Markers

As of June 1, 1929, 23 state highway departments reported that all U. S. highways in their respective states selected for numbering were adequately marked. Nineteen states reported the work 50 to 99 per cent complete, two states 25 to 50 per cent complete and in three states "some" (less than 25 per cent) markers are in place. Of the 25 states where marking is incomplete, the work is being carried on in twelve and will be completed early in 1930. Several of the remaining states are replacing old and worn-out state markers with standard U. S. shields as maintenance items.

Photo Courtesy U. S. Bureau of Public Roads

Pole banding with standard U. S. stencil marker

Caution and Warning Signs

As of the same date (June 1, 1929) 21 states reported caution and warning signs 100 per cent in place. In eighteen states the work is 50 to 99 per cent complete, and one state reports less than 25 per cent. In that state, however, caution signs of non-standard design, erected by an unofficial agency, have been in place on major roads for some time. Of the remainder, all main highways in five states have been adequately signed with signs of state design for some time and three of these are making extensive use of reflecting or luminous signs. In the 27 states less than 100 per cent complete, twelve

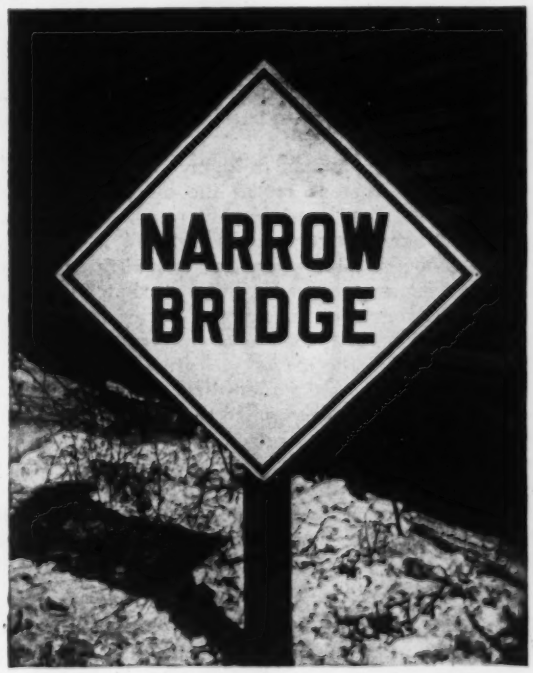


Photo Courtesy U. S. Bureau of Public Roads

Physical hazard inherent in the road. Yellow background with black letters

Standard railroad warning, Yellow background with black legend

report work actively under way, and in seven work is temporarily suspended for lack of funds or other reasons, but will be resumed as soon as possible.

Of the actual number of signs or markers erected, figures are not complete, but with several states not reporting and others supplying merely an estimate, the record stands at 230,800 markers (exclusive of poles stenciled) and 239,900 caution and warning signs.

All but ten states indicate at least an experimental interest in signs of the reflecting or luminous types, and in three or four states considerable investigation and research along this line is being carried on. The question regarding signs of this character seems to be not so much the cost of initial installations, as related to results obtained, as of maintenance charges and replacements due to vandalism. But wanton destruction of road signs is dying out. The small boy has outgrown his target, and to his younger brother the highway sign has not sufficient novelty to appear inviting. The more mature marksman has so improved his aim that anything that is conspicuous as a highway sign should be is not worth a test of skill. The principal offender now seems to be the camper who is too tired to rustle his own firewood, finding it easier to tear down and burn up perfectly good signposts.

The situation as outlined is highly satisfactory, indicating as it does that as far as the interstate highway user is concerned state lines are obliterated. Figuratively, Indiana is thinking in terms of Ohio and Illinois with respect to connecting highways and is interested in continuous marking across and beyond immediately adjacent states, and as progressive marking is carried on the highway user will drive with confidence that he is on the right road. And just as the driver is learning to adjust his speed to the scientific and standardized curve superelevation, so will he learn to recognize and estimate the value of the message on standardized caution signs—taking his foot off the accelerator when approaching a square sign and putting it on the brake pedal as he catches the outline of a diamond shaped sign. To one familiar with the scheme of standardization the actual legend carried on a warning sign is perhaps secondary—the shape of the plaque is sufficient.

Centerline Marking

Although the efficiency of centerline and traffic-lane marking as a factor in highway accident prevention has not been collated, the use of lines of this character on permanent pavements is more or less general in several states and the practice is growing to such an extent as to warrant the assumption that its use indicates potentialities as an element in highway safety. Apparently drivers are realizing that in crossing to the left of a marked traffic line they do so at their own risk, sacrifice all traffic rights and become virtual trespassers. In fact, to motorists accustomed to driving in traffic-marked lanes the center joint in a concrete pavement, whether intended to be a traffic divider or not, is sufficient to keep the driver on his own side of the road.

When used, the centerline is not necessarily restricted to grades with limited sight distance or curves of short radii, but is frequently painted or otherwise marked on long tangents where conditions conducive to excessive speed obtain. At present dividing traffic by marking three or four lanes on the pavement is not a general practice on suburban highways, although it is frequently resorted to under particular and unusual circumstances, or on a highly congested urban approach. On some city streets it has become necessary to divide traffic into three, four or even six lanes in order to expedite movement and to control right- and left-hand turns in each direction.

The use of the line indicating traffic lanes offers perhaps a satisfactory solution for the controversial regulation regarding overtaking and passing vehicles. The present standard code coming from the Conference on Street and Highway Safety, and existing regulations practically everywhere, require that one vehicle overtaking and passing another shall pass to the left. There has been for some time and there is an increasing sentiment for permitting passage on the right in such cases. In cities and suburban areas unquestionably actual practice is in this direction. If, by the use of traffic-lane markings, drivers can be educated to stay in their proper path on the wider highways, it will be possible to permit vehicles approaching from the rear to pass either to the right or to the left, and regulations can so provide without introducing unusual hazard. This condition would ordinarily apply only on very wide highways, principally between large cities in close proximity, or on highways approaching large cities. In this direction the increased

Signs should be visible over parked cars

use of traffic-lane markings appears to have a wide and profitable field.

The Association of State Highway Officials has also adopted as standard a railroad grade-crossing warning design to be marked on the pavement in advance of the intersection. Briefly described, the marker consists of two 2-ft. bars, 10 ft. apart, located 100 ft. from the railroad tracks and parallel thereto, and two 2-ft. bars, spaced 50 ft. apart, about 300 ft. from the track and at right angles to the highway. The letters "RR" 5 ft. high are placed between the bars farthest from the track, and the centerline of the highway is marked on each side of the track for a distance of approximately 325 ft. All marking on the pavement is black on a white surface or white on a black surface.

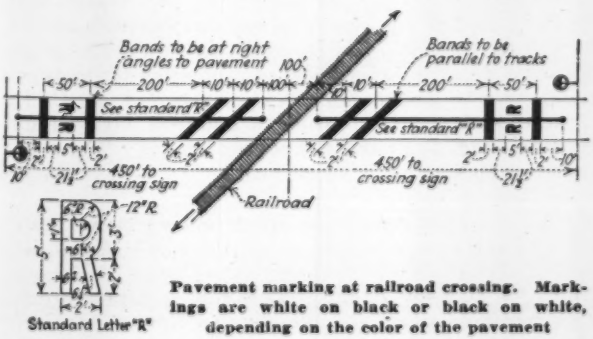
Obviously, this warning can be used only on permanent pavement, and for that reason it is restricted. In an area where there are few permanent pavements and the roads are constructed largely of intermediate highway types, objection has been found to the use of this warning design, because its necessary omission on gravel and other light types of surfaces leads to disregard of crossings, although they may be otherwise indicated by signs.

Pavement Markings as Guides for Air Pilots

Highways when viewed from the air stand out clearly, and if properly identified by number, the main arteries will make a very helpful aid to air navigation. The aeronautics branch of the U. S. Department of Commerce has given considerable study to the subject and in a recent bulletin recommends that air marking on major or through highways be undertaken wherever possible. The marking suggested for this purpose is simple, involving only the appropriate highway route number preceded by the letters "U. S." in the case of U. S. highways, or the abbreviated state name for state highways. The lettering should be done directly on the pavement in characters 10 to 30 ft. high, as the width of the pavement permits, so placed as to read from west to east or south to north, depending upon the general direction of the highway.

The movement to mark the highways as a guide for air navigation is so recent that practically no data that will assist in estimating its value are available. However, two states have asked for a definite marking program and U. S. Highway No. 30 is marked in Pennsylvania in such a way as to be easily read at an elevation of 4,500 to 5,000 ft. Government and commercial aviators report this marking of material assistance.

In addition to the road numbers, the suggestion has been made that place names be painted on the highway surface at the immediate approach to the town. This should prove invaluable and no doubt will eventually be undertaken as a matter of civic pride by chambers of commerce or other local agencies that are already co-operating.



Pavement marking at railroad crossing. Markings are white on black or black on white, depending on the color of the pavement

Photo Courtesy U. S. Bureau of Public Roads

A well-placed route marker. Note reverse direction work at left

* * * *

Safety Progress

By Sidney J. Williams

Director, Public Safety Division, National Safety Council. Has held various positions with the council and has made a long study of safety methods in construction and highway safety methods

SAFETY progress during the year has been in a negative direction so far as highway accidents and deaths are concerned. The cities and states reporting to the National Safety Council, totaling nearly half the population of the country, showed a 7 per cent increase in motor-vehicle deaths for the first ten months of the year as compared with those for 1928. The greatest increase was outside of the cities. The 1929 total will not be far short of 30,000 fatalities.

This growing accident toll results, of course, from the increase not only of motor vehicles but of paved highways and of intercity travel. *We have learned how to build automobiles and highways but not how to use them safely.*

Real progress has been made in the direction of nation-wide uniformity in traffic signs and signals and in traffic laws and ordinances. During the year sixteen states adopted all or most of the Uniform Vehicle Code provisions relating to vehicle equipment and operation, making a total of 25 or more states which are in substantial harmony. The Model Municipal Traffic Ordinance has made similar progress among the cities. Twelve states, however, raised their speed limits (most of them to 45 miles per hour), while Indiana, Iowa, Tennessee and Wisconsin joined Connecticut, Michigan and Montana in doing away with any arbitrary speed limit whatever, specifying only that speed shall not be greater than is reasonable and proper under the circumstances. This is one of the most important points to be decided by the committee recently appointed by Secretary of Commerce Lamont to consider possible changes in the Uniform Vehicle Code and the Model Ordinance.

In the same legislative sessions Maryland, Massachusetts and Pennsylvania authorized by law the periodic inspection of all motor vehicles under state auspices.

The new Massachusetts traffic signal code, promulgated by the state department of public works under legislative authorization and binding upon all local governments, presents the first definite application of traffic

engineering principles in the form of a regulatory code governing the use of all kinds of control equipment throughout the commonwealth. The code is in harmony with the standards recommended by American Engineering Council, but goes farther in specifying minimum volumes of traffic which will be considered as justifying the installation of stop-and-go signals. Each such installation must be approved by the state before it is erected, and existing installations must be brought into harmony with state standards within a reasonable time.

One of the most interesting developments of the year has been the installation of numerous traffic-actuated signals, which do away with much of the annoyance caused by arbitrarily timed equipment.

Highway engineers have shown a commendable ambition to make the highways just as safe in their physical attributes as is humanly possible, through the use of proper widths, grades, curvatures, shoulders, bridges, guard rails, signs, lane markings and other measures discussed elsewhere. Several state highway departments are now collecting and tabulating accurate reports of all accidents on the state highway system, and this information will be invaluable as the basis for intelligent improvements in the highways and the control of traffic on them for accident prevention.

* * * *

Equipment Invention and Application

By William Ogden

Manager, Manufacturers Division, American Road Builders' Association, and previously sales engineer for the Lakewood Engineering Company and the Austin Western Road Machinery Company

IMPROVEMENT rather than invention seems to have been the keynote in the construction machinery field for the year of 1929. The genius in the industry that has been responsible for the development of highway construction equipment has turned its effort toward improvement of existing machines rather than bringing out new ones.

There has been much betterment in the kind of materials used in machinery for highway construction. Much cast iron has been displaced by steel castings; alloy steels that were formerly considered too costly for use in contractors' equipment have been very generally adopted; plain bearings have given way to ball and roller bearings wherever they can be used with economy.

Much has been done to make the diesel engine adaptable to machines for different purposes, and, while there has been no general adoption of engines of this type, there are more manufacturers equipped to furnish them as an alternate of other types of internal-combustion engines than there were a year ago. Taking weight out of the diesel engine and multiplying its cylinders and thereby making it usable in comparatively light machines has made a marked improvement.

In workmanship there has also been much improvement. The trimming up of castings, finishing of parts, banking of levers and grouping of parts relating to operating functions have all greatly facilitated the operative end of many machines in this field.

The designer also has done much to enhance the appearance of the machines. Finer lines have been drawn and neatness in the development of curves and angles has given many machines a much more business-like appearance. Comparison of models of ten years ago with those of 1930 requires only casual observation to show the difference.

Without any particular co-ordinated effort the construction machinery industry seems to be setting up standards of its own that are rapidly bringing it to high levels. The highway engineer under whose supervision the machinery must perform and the contractor who buys it and depends upon its operation for profit have been very largely responsible for the raising of these standards.

Co-operation among the engineer, the contractor and the manufacturer will continue to make construction machinery better, cheapen the cost of its operation, increase its capacity for doing work, and by these means make the modern road cheaper to build.

* * * *

Research and Testing

By R. W. Crum

Director, board of highway research, National Research Council. Formerly testing and materials engineer for the Iowa State Highway Department and research professor in Iowa State College at Ames

THE principal development in highway research in 1929 is the realization that there are many questions of fundamental importance as yet unanswered, and that a comprehensive research program upon which the interested agencies can co-operate is greatly needed.

Physical Research—Thus far the principal achievements in highway research have been in the realm of physical features of highway construction. Naturally the more obvious needs have been cared for first. Now the research workers on the physical side of highway problems are confronted with the more intricate and complicated problems upon the solution of which depends the development of maximum efficiency. For instance, research work has developed methods for producing concrete of predetermined strength, but the question of how to secure maximum economy in the use of the available materials to produce this concrete still needs much study.

Among the more recent developments are: (1) application of sound methods for design of concrete mixtures on highways, (2) accurate methods for field measurement of aggregates and water, (3) methods of testing stability of bituminous mixtures, and knowledge of factors that affect stability, (4) development of materials and methods for producing high-early-strength concrete, (5) increased knowledge of subgrade effects, and application to practice, (6) dissemination of information concerning methods of building low-cost roads, principally bituminous, tried experimentally in many regions, (7) progress in standardization of transverse tests for field use in connection with concrete pavements.

Economic Research—Roads should be so built that the total cost of roadway plus vehicle operation will be as low as possible. The annual cost of providing the roadway should be distributed in proportion to the benefits derived by communities, land owners and users. To make these objectives possible, a thorough study of the economic factors of the situation is needed. The questions which require research are:

1. *Cost of Transportation*—The answers to many of the major highway problems are dependent upon knowledge of the costs of highway service and highway use, and of the effects of the other factors upon these costs. Study of highway transportation cost is hardly begun, and research is greatly needed.

2. *Distribution of Cost*—Studies of such matters as trends in interstate highway traffic; effect of road improvement upon community prosperity and upon land values; effects of different types of roads upon operating costs; relative use of different classes of roads, and use of credit in road building, are needed before correct principles for the distribution of cost in proportion to benefits can be finally determined.

3. *Road Building*—More information is needed upon the effects of the various physical features of the highways upon the items of transportation costs, traffic capacity, unrestricted flow of traffic, and safety. A very important need is the development of some now unknown method of soil treatment that will result in effective low-cost improvement of earth roads.

4. *Traffic Regulation and Safety*—Most regulatory methods in use today have the effect of restricting rather than expediting traffic. "There is a real need for research that will divorce itself from present regulations and conditions and develop the fundamental mechanical and psychological principles upon which regulations that will expedite traffic movement with safety can be based." For instance, clear conception is needed as to the inherent and legal rights of each vehicle in its use of the road and in its relation to other vehicles. Also more definite ideas as to what traffic regulations should accomplish are needed. The principal problem in traffic regulation is the acquisition of basic facts upon which regulatory measures can be based so that the results will not be merely matters of opinion. The principal problem with respect to safety is how to inculcate safe habits in drivers and pedestrians.

* * * *

Shoulder Widths, Construction and Protection

By John D. Waldrop

State highway engineer of North Carolina. Gained promotion through various positions in the department and has devoted particular attention to roadway design and maintenance

IN ESTABLISHING the proper width for earth shoulders adjacent to pavement slabs on highways, the decision should be confined to one of three generally adopted standards, the design of these standards being dependent upon the character of the country, the topography and the terrain through which the road passes. Mountainous locations will call for one of these standards; coastal plain or level-country locations will call for another, and gently rolling or undulating topography will call for the third.

Fig. 1 shows a typical section suggested for mountain-highway construction, where the wide shoulder is not only prohibitive but is usually unnecessary. It is prohibitive because every extra foot of roadway width increases excavation costs tremendously, and is unnecessary because of the total lack of industrial or farm development adjacent to it.

Fig. 2 shows a typical coastal plain boulevard cross-section for adoption in low, level and poorly drained territories. The material removed from the wide, deep side ditches if thrown to the center of the roadway will raise the subgrade of the highway itself above the elevation of the adjacent ground surface.

Through gently rolling or undulating country where excavation costs are not extremely heavy and where, generally speaking, the road traverses a well-developed industrial or farming community the typical section shown in Fig. 3 should be used. This shoulder width gives ample room for all parking that may be necessary on the highway to take care of punctures and breakdowns or to make use of service stations or lunch stands.

The design of the side ditches and their construction are vital factors in the durability and permanency of earth shoulders. The plans prepared to show the proposed highway improvement, setting forth the typical cross-section to be followed, usually show a definite specified dimension for the depth of the side ditch relative to the crown of the roadway. The contractor is required by the engineer in charge to build the road in accordance with this plan regardless of the variation in per cent of grades and regardless of the character of the soil or earth through which the roadway is graded. This should not be.

The depth of the side ditch should be designed with three considerations in mind: (1) the per cent of grade, (2) the character of the soil, and (3) the amount of drainage to be cared for. It is self-evidently an economic waste to require a contractor to machine (and in some cases hand-dress) earth shoulders to the cross-section shown on the plans when it is a known fact that within 60 days, due to one or more of the above-outlined requirements, the ditch will have washed to a depth of 3 or 4 ft. or more and will have carried away in the process about one-half of the earth shoulder. Conversely, if the three considerations outlined above are not carefully studied, it is equally possible that the side ditches may be filled after 60 days.

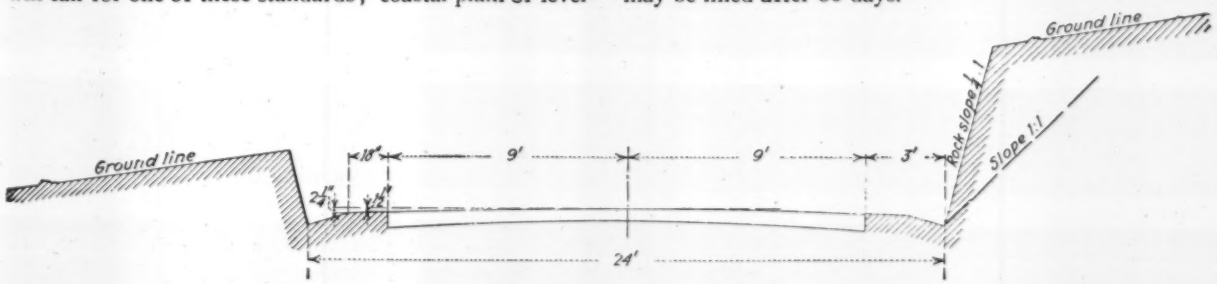


Fig. 1—Cross-section for mountain roads

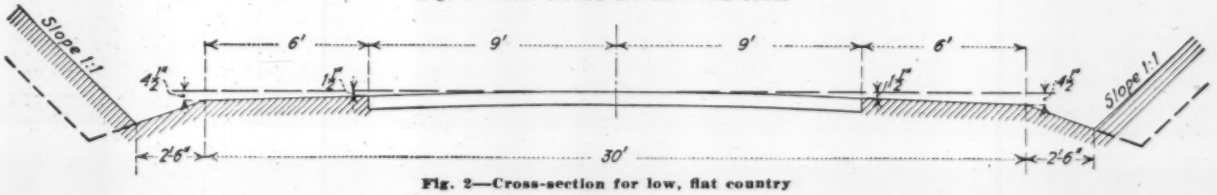


Fig. 2—Cross-section for low, flat country

Fig. 3—Cross-section for gently rolling country

The protection and upkeep of earth shoulders is the largest single item connected with the maintenance of paved roads. It therefore follows that the less money spent on this particular item the greater will be the opportunity to reduce maintenance costs per mile per year. Maintenance equipment has been more or less generally standardized and very little further saving can be effected from this standpoint. To reduce maintenance costs, therefore, patrol sections must be lengthened without increasing either labor or equipment. Proper shoulder protection is the most practical means whereby this can be accomplished. The most economical and dependable protection is grass or sod. It has been clearly demonstrated that grassed shoulders will enable the length of a patrol section to be increased from 25 to 50 per cent; will obviate the objectionable rut usually found at the edge of the paving slab, and will eliminate excessive washing due to heavy rains and floods.

* * * *

Pavement and Roadway Widths

By V. R. Burton

Deputy state highway commissioner of Michigan. Has conducted notable research work on subsoils, frost action and snow removal. Long general experience in state road work

DURING the past year growing appreciation of the necessity for careful design of the entire highway included between right-of-way limits has been strikingly evident. Engineers are no longer content to accept right-of-way widths as they find them established by either dedication or usage, and are not hesitating to demand additional right-of-way as necessity may require. A definite place in the cross-section is assigned to moving vehicles, parked vehicles, drainage, footpaths, underground utilities and overhead utilities and for shrubbery and trees.

Pavement widths are thought of in terms of traffic lanes, with general agreement on the 10-ft. lane as standard. Odd numbers of lanes are falling into disfavor, except where built as a temporary stage in widening to an even number. Separation of the lanes by boulevard center strips is not considered good design unless existing street railways make them necessary. This is especially true where traffic flow is predominantly in a single direction at certain hours, as it prevents an increase of the number of lanes used to take care of the directional overload.

In contrast to the center boulevard strip, some of the best highway designers favor the use of side strips to provide supplementary side pavement for local traffic. It is surprising that the obvious advantages of this scheme have been so generally overlooked in superhighway design. Unquestionably the advantage to the abutting property in the protection that is afforded from the high-speed center traffic is very great. At minor street intersections the protecting strip may be continued straight through and access to the center high-speed lanes be made at more infrequent intervals. The problem of separation of intersecting highway grades is very much simplified by this arrangement.

The conviction is growing that wherever possible surface railways should be completely removed from the superhighway section. Difficulties of grade separation and the danger to cross-traffic make their inclusion in a rapid transit highway system undesirable.

Parallel two-lane highways offer no solution to the traffic problem because of the low capacity of the two-lane highway. It has been well demonstrated that the traffic capacity of the four-lane highway is between three and four times that of the two-lane, due to the increased efficiency in separation of slow and fast vehicles. It is possible to develop a four-lane highway within the old 4-rod right of way, although it will be found that results are far from satisfactory for placing utilities and planting. Parallel highways should not be considered until the present highway has been developed to at least a 40-ft. width. Considerable right-of-way cost is justified in preserving the investment in the old highway.

The following widths of right-of-way are considered to be reasonable standards:

1. Local roads, limited to two lanes for moving vehicles plus parking—66 to 86 ft.
2. Primary and secondary trunk lines in well-settled communities, limited to four lanes for moving vehicles plus parking—100 ft.
3. Primary highways limited to six lanes for moving vehicles plus parking—120 ft.
4. Superhighways with provision for high-speed motor traffic separate from local traffic, with ten lanes for moving vehicles and four parking strips—200 ft.
5. Special snow-belt trunk highways for two-lane traffic, but with provision for permanent snow fence and protective planting within the right-of-way—150 to 300 ft.

* * * *

Trends in Road Surfaces

By C. N. Conner

Engineer executive, American Road Builders' Association. Born 1882; graduated Tufts College 1908; U. S. river and harbor work and later highway design and construction in Delaware, North Carolina and Mexico

HIGHWAY surfaces are commonly grouped as low-type, medium-type and high-type, although two groupings are sometimes used. Low types are relatively low in first cost and have a relatively low capacity for traffic as compared with the medium and high types. Trends in practice of federal-aid roads, state highways and county and township highways are indicated by the charts, Figs. 1-3.

A general picture of trends and progress may be had from the charts, but present trends in specific types are the basis of present planning for future construction. Only the outstanding elements are considered. Some of the types do not represent general practice, but are given because of their probable growth in popularity.

Low-Type Untreated Surfaces—The use of local, short-haul materials for light-traffic roads will continue, but with a more careful selection of materials, improved construction methods and better maintenance. Earth roads will be more thoroughly maintained and their serviceability increased. The traffic-bound road of

crushed gravel, crushed stone and slag will grow in popularity and will continue to replace waterbound macadam.

Low Types of Bituminous Surfaces — Bituminous treatments of clay and some other subgrades before applying traffic-bound surfaces will increase because less surfacing aggregate is required, dust is reduced, aggregate does not sink into subgrade or become lost in ditches and frost boils are reduced in number. Surface treatment by successive application is being replaced by mixed-in-place surfaces. The premixed type of surface laid at atmospheric temperatures is slowly gaining in popularity. Crushed angular aggregate for these types will be preferred.

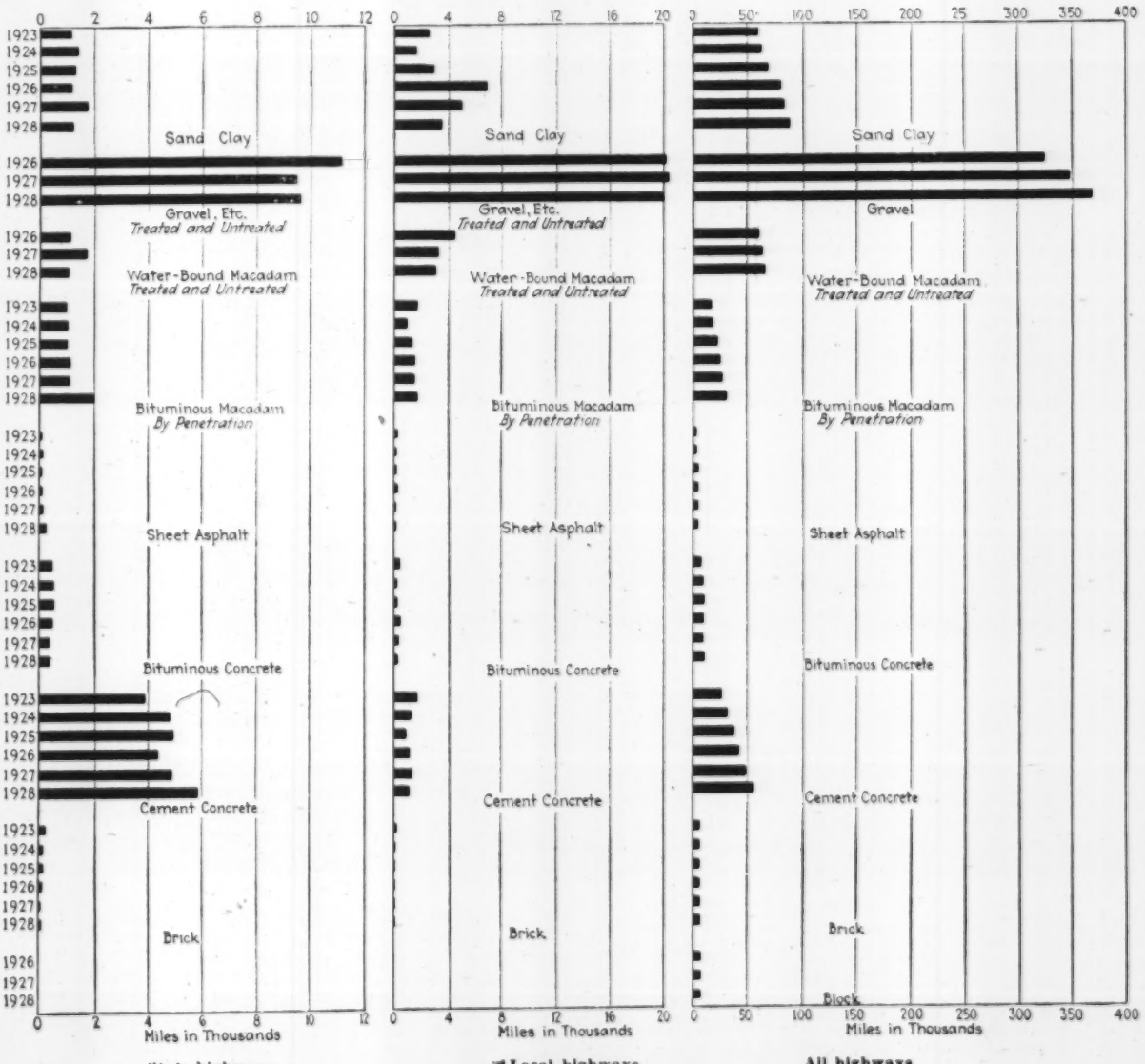
Bituminous Macadam—There is a tendency to use larger stone for the coarse aggregate than was used in past practice. Cold bitumens of the cut-back or emulsion type are being used to a limited extent. Bituminous macadam is not growing in popularity, but blading and dragging are producing smother-riding surfaces.

Portland Cement Concrete—Trends in this type include a wider use of: (1) longitudinal joints and planes of weakness, (2) transverse joints and transverse planes of weakness, (3) local sand-gravels as aggregate, (4) reinforcement in sections subject to frost action or poor subgrades with a preference for small steel members closely spaced, (5) weight instead of volumetric proportioning, (6) flexure tests for determining strength of pavement, (7) separate proportioning by weight of fine and coarse aggregates and (8) raised thickened edges and relatively wider sections of uniform thickness instead of the standard practice for thickened edges.

Other Types—Hot-mixed and hot-laid bituminous surfaces are greatly improved and costs are reduced somewhat by machine finishing instead of hand finishing.

Thinner brick is laid on sand bedding with bituminous filler instead of sand-cement or other types of bedding with cement filler. Other types of block pavements for rural highways are decreasing in use.

In summary, the evident trends are toward: (1) increased service to rural communities by traffic-bound roads which will be improved later by low-cost bituminous surfaces, (2) progress in methods for improving subgrades, (3) smoother riding qualities in all types of surfacing, (4) crack control in concrete pavements, (5) more accurate proportioning of concrete aggregates and (6) the use of crushed aggregates for low-type bituminous surfaces and a wider use of local sand-gravel for concrete.



Figs. 1 to 3—Practice in road surfacing classified by types of roads

From Job and Office

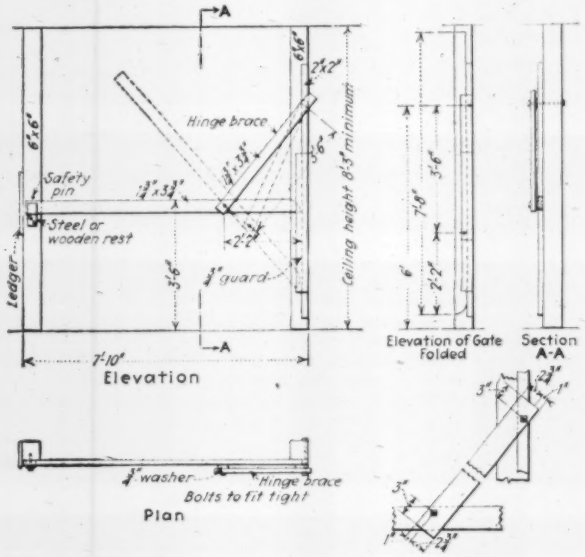
Hints That Cut Cost and Time for the Contractor and Engineer

Simple Elevator Safety Gate

By G. E. Peachey

Foreman, Morton C. Tuttle Company, Boston

A SIMPLE elevator safety gate consisting of a single crossbar and hinged brace has been adopted as standard for use with platform elevators in building construction by the Morton C. Tuttle Company. This



Elevator safety gate for building construction

gate, devised by the writer, is shown in the accompanying sketch applied to 6x6-in. elevator posts. The gate, when closed, forms a substantial, effective barrier. It has the advantage of simplicity of construction and operation, requires little operating space and, when open, obstructs no part of the elevator opening, simply folding back on its supporting post.

Photo-Copy Method Produces Cheap and Convenient Road Plans

By F. Cnare

Plan Engineer, Wisconsin Highway Commission

FEDERAL plans printed by photo-copy instead of blueprinting methods are now furnished by the Wisconsin Highway Commission to its road contractors. Advantages of the photo-copy method are the convenience of the smaller plans over the present cumbersome 22x36-in. size, the permanency of the resulting prints and greater economy.

The equipment used consists of one 18x24-in. photo-copy machine which, with one operator, prints, develops, fixes and washes the sheets automatically. Five mercury vapor lamps, a trimming board and sorting tables complete the equipment, the total value of which is approximately $2,700. Four original 22x36-in. federal sheets are placed in pairs on frames, held with spring hinge clasps and then hung on an easel. The reduced prints are 7½x12 in., plus binding margin. Four vacuum tubes are necessary to secure proper illumination, the one across the bottom of the easel being so altered as to throw its light upward. A run of 2,000 prints per ten-hour day has been secured. The machine delivers the finished prints to a tray in exact order and as many as ten sheets, each containing four reduced plans, may be clipped together and trimmed at once. The original drawings, being in exact sequence, are more easily sorted than when received from the ordinary blueprinting machine. The method requires that special attention be paid to certain details on the original. Larger lettering must be used, with heavier lines, in order that detail be not dropped in the reduction.

The total cost of operation during the past year, with an output of 77,000 prints, was $6,301, an average of 8.22c. per print. This cost includes operator's time, overhead of $1,000, interest, depreciation at 20 per cent, power, water, paper and chemicals. It does not include rental, as spare space was available. The average cost of blueprinting during the previous year was 12.63c. per print, this price being paid to a commercial concern.

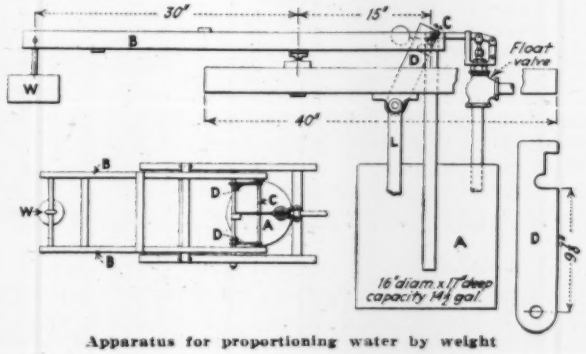
This method is not economical if full-size prints are made, as the saving comes in the reduction. Some contractors have objected to the smaller plans, but most of them are pleased with their convenience. Although some full-size blueprints are required on the job, the smaller sets are especially desirable for bidding purposes.

A Job-Made Water-Weighing Device

By Miles N. Clair

Vice-President, Thompson & Lichtner Company, Boston, Mass.

PROPORTIONING materials for concrete by weight instead of by volume has so many advantages that it is somewhat surprising that the weighing method has not been more generally adopted. The number of installations using weight as a basis for proportioning is increasing, but few do more than weigh the aggregates and cement. Water-weighing equipment for concrete plants in general has not been developed nearly so much as has aggregate-weighing apparatus.



Apparatus for proportioning water by weight

Details of a job-made water-weighing device used successfully on work under the writer's supervision are shown in the drawing. The apparatus consists of a cylindrical container *A* counterbalanced by an adjustable weight at the end of a beam *B* supported on knife edges. Conditions are shown as they obtain when water is first admitted to the container. A float valve is held open by the rod *C*, which falls as the water in the container overcomes the weight *W*. At the point in its travel that the pin *C* reaches the notch in the latch bar *D* the float valve is suddenly seated and the flow of water stops. The water is drawn from the container through a quick-opening valve at the bottom. The apparatus is reset for filling by moving the lever *L*, which moves the latch bar. Adjustments in the quantity of water are made by changing the weight *W*.

Messrs. Shenk and Geyer, of the Federal Cement Tile Company, are responsible for the design as shown.

Highway Data Presented Graphically for Convenient Reference

A GRAPHICAL method of presenting essential highway data is used by the maintenance department of the California Division of Highways. The mileage of the highway system is plotted in sections of convenient length to show such information as the width and character of the highway, the annual maintenance cost, the present peak traffic and the estimated peak traffic in 1940 to indicate the adequacy of the roadway width. Information in this form has proved convenient in considering the expenditures for maintenance and also is an aid in checking the recommendations of the division engineers for appropriations from the highway budget.

The accompanying drawing illustrates the method used. It covers a portion of the state highway system about 40 miles south from the San Francisco city limits as indicated by the mileage scale along the top. Relative widths of the highway are shown and the type of paving is indicated. Portions of the highway in incorporated towns are omitted and appear as gaps, since they are not part of the state system. The annual maintenance cost for corresponding sections of the highway are represented graphically immediately below. This shows at a glance the sections having high maintenance costs and any unusual increase in such costs for any one year.

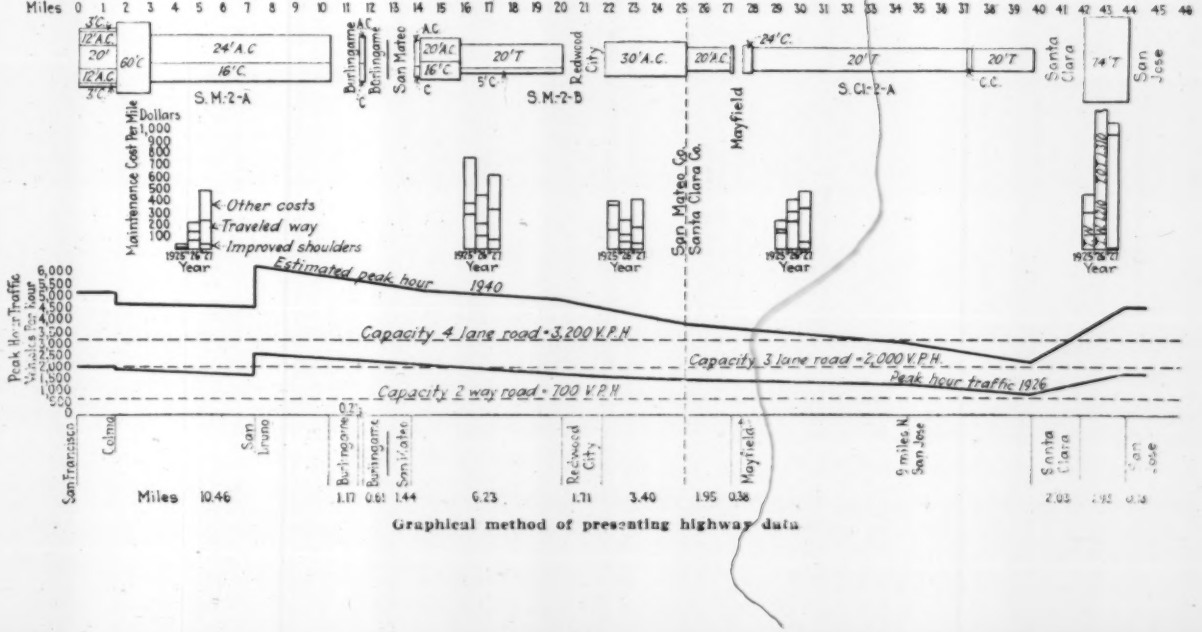
The lower section of the chart is used to illustrate the present and future traffic load and the corresponding roadway width required for the highway represented directly above. The capacities for various roadway widths, based on extensive studies of the maintenance department, are estimated to be 700 vehicles per hour on a two-lane roadway, 2,000 vehicles per hour on a three-lane roadway and 3,200 vehicles per hour on a four-lane roadway. These figures represent approximately the peak-hour traffic load, or 10 per cent of the traffic for the sixteen-hour period from 6 a.m. to 10 p.m., and it is estimated that they may be exceeded by 30 per cent, which is the factor of safety provided. These figures are used to interpret the results of actual traffic counts and the estimated future loads.

As an example, referring to the drawing at a point where the boundary between San Mateo and Santa Clara counties is indicated, the following facts are presented graphically: The peak-hour traffic based on the 1926 count is approximately 1,500 vehicles per hour and, according to the estimated capacity, a two-way roadway is insufficient but a three-lane roadway is ample for the traffic at this point. The estimated peak load at this same point on the highway for 1940 is approximately 4,000 vehicles per hour and the curve shows that a four-lane roadway at this point would not be sufficient for this peak load.

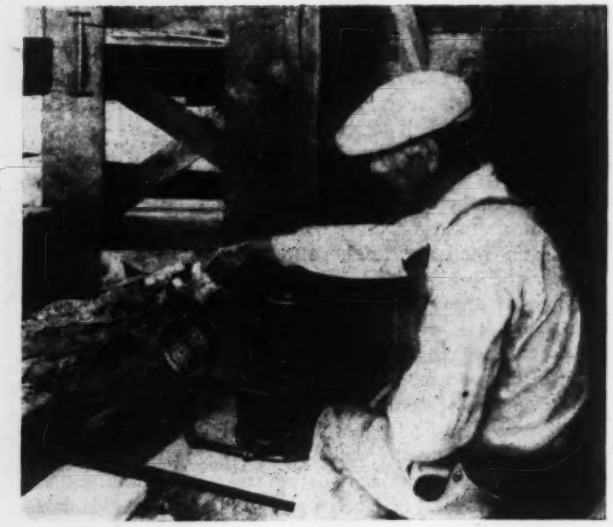
The foregoing method of presenting highway data originated in the office of T. H. Dennis, maintenance engineer of the California Division of Highways.

Hydraulic Jack Used in Making Pile Bearing Tests

IN MAKING pile tests at the site of the new Milwaukee County courthouse, the S. M. Siesel Company, contractor, used a hydraulic jack to apply test loads in place of the usual weight balanced upon a pile. A crib was erected and filled with approximately 100 tons of dirt to act as a backstop for the jack, which was interposed between the pile and the crib. Each pile to be tested was carefully leveled and a steel plate grouted on the top. The jack was placed on the plate and a section



Graphical method of presenting highway data



Testing soil pressure with hydraulic jack

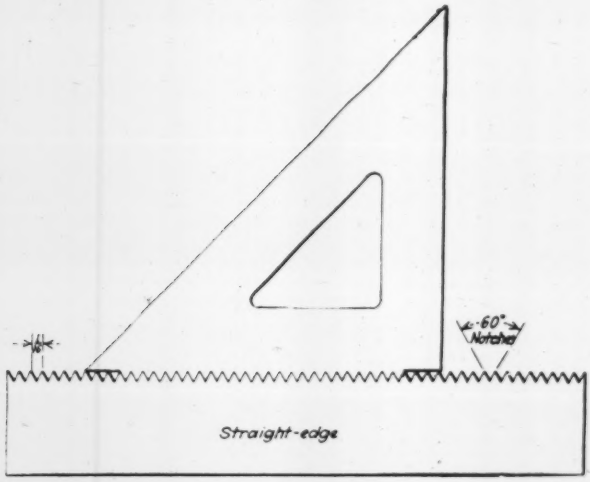
of 12x12-in. timber interposed between it and the crib bottom. Deflections were measured by a light cable fastened to the steel plate and connected to a long multiplying pointer which registered ten times the actual deflection of the pile.

The initial pressure exerted by the jack was 10 tons and this was increased 10 tons each half-hour until 30 tons was reached. Deflections were recorded periodically. This load was sufficient to meet the requirements of the Milwaukee building code. However, the tests were continued at the rate of 5 tons increased load each half-hour until a 50 per cent overload, a total of 45 tons pressure, was reached. This pressure was held for 24 hours.

A Cross-Sectioning Triangle

By Morton Schwam
Philadelphia, Pa.

EVERY simple method of drawing evenly spaced cross-section lines on a drawing may be accomplished by using a triangle and a straight-edge as shown in the illustration. A 60 deg. V-notch is filed in a straight-edge $\frac{1}{16}$ in. deep and corresponding notches are filed in one edge of a triangle. When drawing cross-section lines the draftsman moves the triangle along the straight-edge from one notch to the next, thus saving time over adjusting the triangle in the ordinary manner and at the same time assuring evenness in the cross-sectioning.



Cross-sectioning triangle

Making Tight Joints in Concrete Pipe

By Emerson C. Hallock
Chief Inspector, Westchester County Sanitary Commission, White Plains, N. Y.

SPECIFICATIONS for the construction of trunk sewers for the Westchester County Sanitary Commission, White Plains, N. Y., call for a test under a 4-ft. head of water. This is very necessary because pipes are usually under groundwater level and often cross under streams with inverts as much as 10 ft. below water level.

On one such job where precast vibrated concrete pipe was used the contractors, A. Gregorio & Company, New York City, took unusual care in making up slip joints. In the method developed the first step was to place an extra heavy bituminous sewer compound around the sleeve end of the pipe as it lay in the trench. A thick continuous strand of jute was then packed into this compound and the pipe placed into position and jacked home with screwjacks. During this process the spigot end forced jute and sewer compound into the groove of the sleeve end. The jute was then calked both outside and inside, more being added when required. As a final step a 1:2 mortar was placed around the inside of the joint and grout was poured around the outside, using a light packing of jute or burlap to hold the grout in position. This packing was removed after the grout had set and the remainder of the joint filled with 1:2 mortar. The making up of the mortar joint was not done for several days after the pipe had been laid, to avoid damage by settlement.

Typical hydrostatic tests on two lines with diameters of 24 and 30 in. laid in this manner showed only about half the allowable leakage stated in the specifications. Tests were made on 400-ft. lengths of pipe laid in lengths of 4, 8 and 12 ft. Leakage was considerably less than 1 gal. per day per square foot of inside area for any 100-ft. length.

Method for Rapid Setting of Form Points on Small Arch Dam

By James Girand, Jr.
Civil Engineer, Phoenix, Ariz.

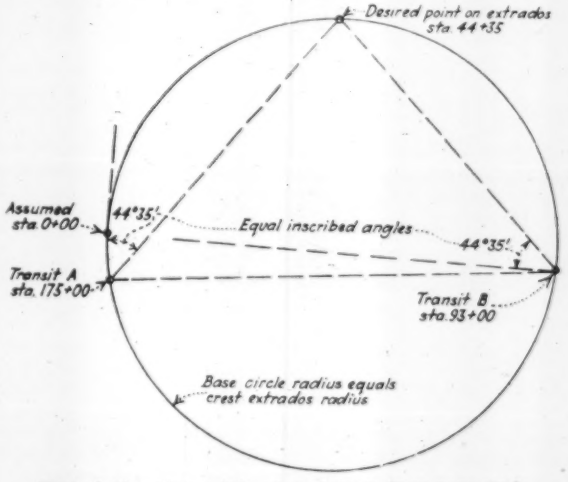
SETTING points for the formwork on a small arch dam by means of intersecting lines from two transits placed at convenient points on the circle forming the arch proved an easy and rapid means of doing this work in a structure recently built near Safford, Ariz. The dam is of the variable-radius type, 120 ft. high; the radii vary from 14 ft. to 80 ft., changing with every 10-ft. increase in height, thereby necessitating many changes in form alignment. The structure was described in *Engineering News-Record*, Oct. 10, 1929, p. 569.

Preliminary work consisted of accurately establishing a base or reference circle on the ground by locating eight or ten points suitable for transit set-up. In this case the base circle selected was the extrados of the crest, having a radius of 80 ft., because it intersected all the lower arch segments which were located later from their respective circles. The instrument points consisted of

phonograph needles set in cement in drill holes in the rock; the needles projected above the cement enough to be visible for a sight.

The system is based on the fact that, in the same circle, equal inscribed angles subtend equal arcs. Any convenient instrument point on the base circle was assumed as zero and the other points were located by the inscribed angles from this point. For convenient reference the degrees around the circle starting at the zero point were called "stations"—thus the inscribed angle of 18 deg. and 35 min. was called Station 18 + 35. Points to be set along the arch also were given station numbers according to the inscribed angle in degrees and minutes from the zero point.

The operation of setting any form point after establishing this circle was simple and rapid. Two transits were set up on any two of the points on the circle and



Method of setting points on arch form from base circle

were "oriented to the circle." This required setting the plates at zero and sighting the transit on Station 0 + 00 (the assumed zero point of the circle). If Station 0 + 00 was not visible from the point selected, the plates were set to read the angle of any visible station and the instrument was sighted on that point, which had the same orienting effect. After orienting both transits, all that was required to set any desired form point station was to set the station angle of the point on each transit and locate the point of intersection of the lines of sight. No computation was necessary, since the station number was set directly on the plate of the transit.

For example, referring to the accompanying figure, assume it is desired to set a point on the base circle (extrados of the crest) which is Station 44 + 35. Transit *A* is set up on a convenient point, such as Station 175 + 00, on the base circle and oriented by setting the plate at zero and sighting on Station 0 + 00. If this back sight could not be seen, the plates might be set at 93 deg. and sighted on Station 93 + 00. The station of the point occupied is immaterial and does not need to be known. Transit *B* is also set up on the circle and oriented in a similar manner. The verniers of both transits are then set to read 44 deg. 35 min. and the intersection of the lines of sight establishes the required point. The only disadvantage of this method is that the angles cannot be doubled without computation, unless the zero station is the back sight.

Complete utilization of this method requires that the circles defining the lower sections of the dam be located from the base circle previously established. Because the base circle cuts all the lower circles, the points of intersection could be calculated with respect to Station 0 + 00 of the base circle from the design data. By occupying convenient points on the base circle from which these points of intersection were visible, they could be established on the ground by intersecting lines from two transits. The new points for the lower circles so located, including those at the bottom of the canyon in the case of the lowest arch section, were used to establish the circle at such elevations. Reference points were then set on them out of the way of construction work for future use in setting the arch forms. When construction had advanced to the elevation of a given circle, the points for the forms were set in the same manner as described for the base circle.

By this method even the circle and forms for the lowest section of the dam with a radius of 14 ft., more than 100 ft. below the crest, were established without any field calculations, chaining or plumbing. The only chaining required for the entire layout was a 100-ft. base line from which topography and the base circle were located. The thickness of the arch being known from the design for the various points along the arch at different elevations, the intrados was located by measuring from the extrados points as set by the transits.

Cableway Removes Debris and Forms on Concrete Building Job

By Zara Witkin
Chief Engineer, Herbert M. Baruch Corporation, Los Angeles, Calif.

A SIMPLE but effective cableway system was arranged for stripping forms and removing debris on the Cedars of Lebanon Hospital in Los Angeles by the contractor, the Herbert M. Baruch Corporation. The cableway was especially effective in saving rehandling form panels and form lumber in removal from the building to a storage yard several hundred feet distant. As detailed in the accompanying illustration, the cableway system consisted of a track cable carrying a carriage block from which was suspended a pulley carrying the hoisting line. The track cable was anchored to the top of the building at one end and to a deadman in the storage yard at the other end, passing over a 15-ft. A-frame near the deadman to provide ground clearance. The

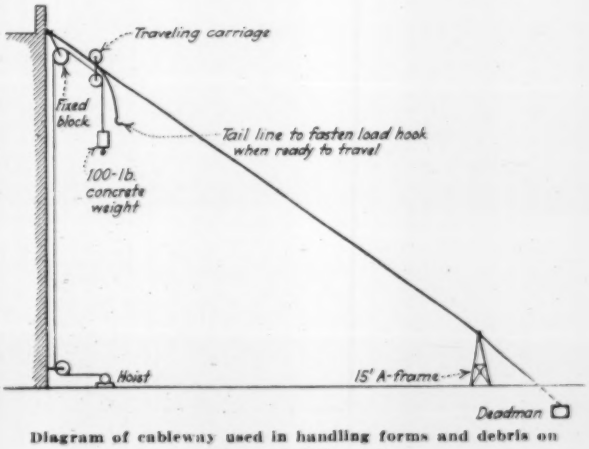


Diagram of cableway used in handling forms and debris on concrete building job

hoistline ran from a hoist placed in the basement, up the building wall through a fixed pulley near the top of the track cable and out through the lower pulley on the carriage, ending in a 100-lb. weight and hook. Slings carrying the material were fastened to the hook.

To operate the cableway, after the load was in the slings, it was hoisted to the top, where it was fastened to the carriage by means of a short tail line and hook engaging the counterweight on the hoistline. Then by slacking off on the hoistline, the load traveled by gravity to the lower end of the track cable, where it could be easily swung into the desired location before releasing the tail line. Taking up on the hoistline returned the carriage and slings to the top of the cableway, ready for another load.

Letters to the Editor

Wind Action on Hangers in Steel Arch Bridges

Sir—Referring to the broken hangers in the Tacony-Palmyra bridge, the editorial "Wind Vibration Again" in the Oct. 24 issue gives some readers the impression that the type of structure—arch with suspended floor—is new, and that therefore it presented conditions never before encountered, as extenuating the omission of bracing on the long tension members. These have a ratio of length to flange width of about 137.

The type of structure is not new, nor is the particular type of floor hanger there used—plain I-beams; neither is the fact of such members being subject to flapping and requiring stays. A 270-ft. steel arch on the line of 42d St. in Philadelphia over the main line of the Pennsylvania Railroad, with 15-in. plain I-beam hangers carrying the concrete floor, was designed by the writer and built in 1908. It is shown in the accompanying illustration. The hangers are 50 ft. long with 6-in. flanges, giving a ratio of 100, and they are steadied by a continuous line of struts to prevent flapping. The transverse bracing, carried to within 14 ft. of the floor and acting in the direction of the webs of the beams, contributes appreciably to the lateral stability of the arch. A recent inspection, inspired by the editorial referred to, failed to disclose any effect of vibration.

The editorial attributes the essential cause of the breaks to "resonant vibration." Can that really be the cause? Resonant vibration is what produces the phenomenon of sound, and is very small in amount of movement because of its high frequency. It produces the sound that we like to hear in a bridge, because it indicates that everything is secure and properly tight. The movement of these Tacony bridge hangers must have been much more than that attending mere resonance. A web side pressure of 22 lb. per square foot, which a 75-mile wind is said to give, would cause the hangers to bow longitudinally over 1 in., with both ends rigidly fixed and without any reduction of flange section. However, they are spliced at or near the mid-point and are riveted at the ends, whereby the attending loss of section must have increased the bending stress and the bowing. Whenever wind pulsations became regular enough to synchronize with the beam oscillations the resulting cumulative effect must have caused a really high intensity of fiber stress. (This synchronization is what we referred to as resonant vibration.—EDITOR.)

Another influence operating to set up flapping is the vertical vibration of the arch under traffic, and perhaps also under wind impulses on the large floor area. These slight undulations communicate movement to the hangers through the fixity of their attachment, and may be amplified by synchronic accumulation, gathering volume and force until the impulse in the arch subsides. I have seen this effect in rod tension members, the movement at the middle alternately growing and declining, repeating as long as the actuating impulses continue.

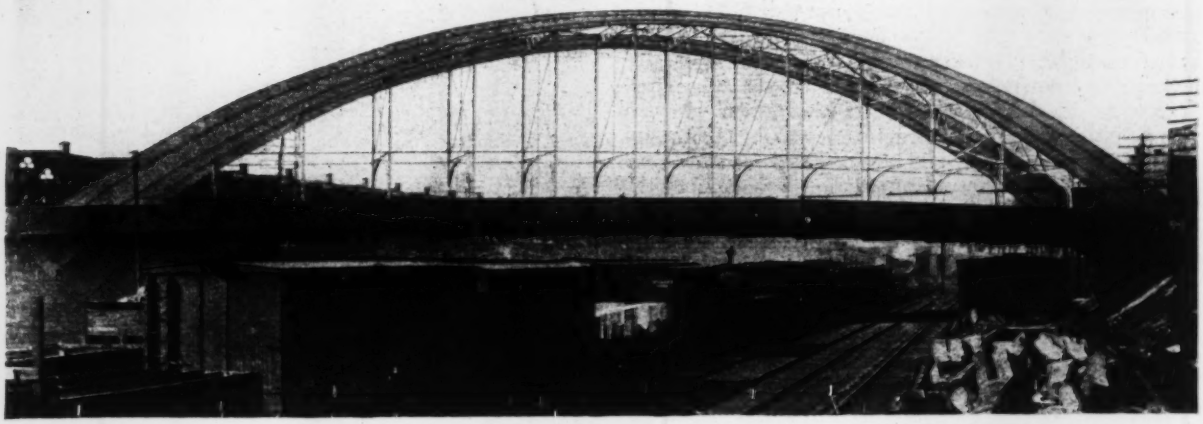
With respect to bar hangers and bar diagonals, they, too, are subject to flapping and often are tied together or to another member to steady them. However, if they are not fixed rigidly at the ends they are not subject to the destructive synchronic accumulation of vibratory force. Therefore their breaking is not common.

I recall at the moment four eyebars that broke at the eye in service in bridges here in Philadelphia within the past eight or ten years. Two of them were in different spans of a railroad bridge over the Schuylkill River, and the other two were a pair of end diagonals in a span of the South St. city bridge over the Pennsylvania Railroad. The broken railroad bridge bars were discovered in routine inspection, but the South St. bars—or at least the second one—gave way under traffic. The top chord was a stiff continuous box, and although it dropped over 12 in. before the live load moved from the end of the floor, it did not fail and thus saved the span from falling.

All these bars were of moderate size and length, perhaps 5 or 6 in. x ⅞ or 1 in. and 18 or 20 ft. long. Probably not one of them was rigidly fixed at the ends and therefore was not subject to the severe bending that vibration induces at a point of fixity. The most generally accepted theory of these breaks was that the material was defective in the forged eye.

However, so far as the Tacony bridge is concerned, synchronization of wind impulses with the oscillations of the beam hangers and the possible effect of vertical vibration of the arch itself under traffic should account adequately for the breaks.

HENRY H. QUIMBY,
Philadelphia, Pa., Dec. 7, 1929. Consulting Engineer.



Forty-second Street steel arch bridge in Philadelphia. I-beam hangers used similar to those in Tacony-Palmyra bridge. Note continuous longitudinal struts as well as transverse portal bracing at each hanger, designed to eliminate flapping.

News of the Week

Contract Awarded for Viaducts in Pittsburgh District

Six viaducts, a large bridge over the Youghiogheny River at Banning and three tunnels are included in a contract recently awarded to the Vang Construction Company, of Pittsburgh, Pa., by the Pittsburgh & West Virginia Railroad. The work forms part of the road's Cochrans Mills-Connellsville extension, and is the third awarded to this company by the railroad. The section just let crosses in almost a straight line from the Monongahela to the Youghiogheny River, crossing the latter on a high bridge and then by means of a 1,500-ft. tunnel to the Jacobs Creek valley, which it follows for a distance of about 8 miles to the Scottdale terminus. Operation over the new tracks is expected to begin some time next May. The contract price was $4,500,000.

Tri-State Conference Again to Discuss Boulder Dam Problems

Representatives of the states of Arizona, California and Nevada will again confer on the problems of Boulder dam, Secretary Wilbur has announced. Following an exchange of messages with the governors of the states, a meeting will be held, probably in Phoenix, Ariz., on Jan. 6. For this meeting there will be added to the regular members of the Colorado River Commission of each of the participating states a special representative appointed by the state governor. William J. Donovan will attend as the representative of the government.

The general plan is that this shall be a friendly meeting to adjust certain differences that exist among the states, particularly in reference to the allocation of the water which will be made available through the erection of the dam. It has been agreed that no one is to be bound finally as a result of the deliberations, but it is hoped that an agreement can be reached and a report made not later than Feb. 1.

North Carolina Completes Bridges Over Cape Fear River

Two long bridges over the Cape Fear and North East rivers at Wilmington, N. C., have been completed by the North Carolina State Highway Department and are now open to traffic. Bonds totaling $1,250,000 voted for the construction of these bridges will be retired by toll charges at a nominal rate of 25c. per vehicle. The two bridges are connected by a new highway half a mile in length. With the new Cooper River bridge at Charleston, S. C., and the new James River bridges at Newport News, Va., the Wilmington bridges complete the Atlantic Coastal Highway between Maine and Florida. All except 7 miles of this route is now paved.

The North East River bridge, 2,194 ft. in length, consists of two deck truss spans 141 ft. long, one deck truss span of 177 ft., two similar spans 185 ft. long, a double-leaf bascule span totaling 185 ft. and steel trestle approaches. Similar in design but shorter, totaling but 1,520 ft., the Cape Fear structure consists of steel trestle approaches, three 125-ft. deck truss spans and a double-leaf bascule span 185 ft. long. The structures were designed by the state highway department under the direction of John D. Waldrop, chief engineer, and W. L. Craven, senior bridge engineer, assisted by Waddell & Hardesty, consulting engineers, New York. Contract for the substructure was held by Merritt-Chapman & Scott Corporation, New York. The Vincennes Bridge Company, Vincennes, Ind., was contractor on the superstructure, including the bascules.

Los Angeles Reorganizes Municipal Departments

In a recent reorganization of the Los Angeles department of water and power two subdivisions were re-created: the bureau of power and light, with E. F. Scattergood as chief engineer and general manager, and the bureau of waterworks and supply, with H. A. Van Norman as chief engineer and general manager, both reporting to the board of water and power commissioners. Additional personnel also was announced as follows: H. C. Gardett, engineer of electrical design and construction, and C. P. Garman, assistant; T. A. Panter, engineer of electrical operation, with Roy Martindale, assistant. Both Mr. Gardett and Mr. Panter report to Mr. Scattergood. Reporting to Mr. Van Norman are W. W. Hurlbut, engineer of water distribution and operation; James E. Phillips, engineer, Owens River aqueduct; and Frank E. Weymouth, engineer of design and construction.

CABLE SPINNING STARTS ON POUGHKEEPSIE BRIDGE

Following the completion of the footwalks, cable spinning for the 1,500-ft. suspension bridge over the Hudson River at Poughkeepsie, N. Y., started Nov. 29. The structure is being built by the Department of Public Works of the State of New York, with Modjeski & Moran as consulting engineers and the American Bridge Company as contractor for the entire superstructure. Completion is expected in July, 1930.

Palm Beach County Wins Claims for Lake Worth Bridge Collapse

Palm Beach County, Florida, settled out of court its suit for damages arising out of the collapse of the Lake Worth bridge between West Palm Beach and Palm Beach during construction Dec. 29, 1921, against the Maryland Casualty Company, bond underwriter, and A. S. Hecker, contractor, shortly before the suit was to come to trial on Dec. 12, 1929, in the U. S. District Court. Terms of the settlement netted the county $65,000 after expenses were paid. As reported in *Engineering News-Record* Jan. 26, 1922, p. 148, three 63-ft. barrel arches of a concrete highway bridge being built between the two cities collapsed and the intervening piers were destroyed. After the collapse the contractor abandoned the work and a new contract was necessary to complete the structure. Engineering reports state the cause of the failure was due to unsymmetrical filling of the spandrels with dredged sand, though there was also indication of faulty construction in both piers and arches.

Palm Beach County neglected to bring suit against the bond underwriter for several terms of county commissioners. Suit was finally filed by the board of commissioners taking office in January, 1927, through its attorney, Rufus M. Robbins, of West Palm Beach, the suit being instituted in the Circuit Court and later transferred to the U. S. District Court.

San Diego Voters Reject Proposed New Charter

A proposed new charter for San Diego, Calif., which would have established a complete council-manager plan, was defeated on Dec. 19 by a vote of 14,316 to 8,704, with about 30 per cent of the registration voting. Since 1915 San Diego has had an operating department, headed by a manager in charge of water, sewer, street, harbor, engineering and other bureaus (see *Engineering News*, July 22, 1915, p. 187).

New Bridge to Be Built in Vancouver

At the recent municipal election at Vancouver, B. C., the ratepayers authorized the expenditure of $4,200,000 for four major projects, including $2,800,000 for the Burrard St. bridge, $750,000 for sewers, $300,000 for the development of a city airport and $350,000 for new fire alarm headquarters.

The Burrard St. bridge will be a link in the main traffic artery providing direct access to the Point Grey section of the city and will form an important part of Vancouver's town-planning program. The proposal is to erect a double-deck bridge over the False Creek inlet, with the upper deck to be used by vehicular traffic and the lower deck for street cars and steam railway lines serving the industrial areas in the vicinity. The city council was authorized by the electorate to proceed with its investigations of the power potentialities of the Checkamus River and its tributaries with a view to ascertaining if this river, on which the city has a reserve, can be developed for civic hydro-electric purposes.

Traffic Congestion Studies to Be Made in Baltimore

The U. S. Department of Commerce is preparing to make a survey of the traffic conditions in Baltimore, Md. Special attention will be paid to the causes and effects of congestion in the downtown areas for the purpose of determining the economic considerations to be given to traffic and parking regulations. A careful check-up will be made of the migration of business to uptown locations and the shopping habits of the population. It is expected that the results of the survey will be of great assistance in handling the serious problem of traffic congestion in cities.

While preparations are under way for the Baltimore study, the National Conference on Street and Highway Safety is debating the advisability of reviving the model traffic ordinance. It is claimed that changed conditions brought about by mechanical improvements in motor vehicles and the better type of highways now being provided make it desirable to adopt certain modifications in the ordinance. Suggestions have been made that speed limitations be abolished on the open road inasmuch as speed alone has little to do with safe operation.

The Business Outlook

At the turn of a year slight signs of the direction of the business movement from week to week become significant. If they show the patient is not getting worse, they give some ground for believing he is getting better. There are several such in the latest indicators. Steel production is holding a fairly constant level at a time when sharp curtailment is usual. Car-loadings of non-bulk goods are not dropping further below last year's figures than they did during the latter part of November. General trade made a good comeback in the pre-holiday week and was practically at last year's level.

All these things suggest that the general expectation of returning business confidence and of impending revival of industrial activity early in the year is being justified.

—The Business Week, Jan. 1.

Hearings Resumed on Arkansas River Dispute

Hearings on the Colorado-Kansas suit over waters of the Arkansas River have been resumed in Denver after a recess. M. C. Hinderlider, Colorado state engineer, was the first witness. Cross-questioned at length by W. E. Stanley, special counsel for Kansas, and F. Dupont Smith, representing the Finney County (Kansas) Water Users' Association, he submitted oral evidence, maps and charts seeking to prove that Kansas has used more Arkansas River water than was allocated to it by a U. S. Supreme Court decree of 1907.

Rock Island Extension in Texas Approved by I.C.C.

Authorization has been granted to the Chicago, Rock Island & Pacific Railroad by the Interstate Commerce Commission to build a 58-mile extension in the North Plain territory of Texas. The new line will connect Dalhart on the main line with the Amarillo-Liberal line at a point just south of Morse. Single-track construction is contemplated, with a maximum grade in either direction of 0.5 per cent and a maximum curvature of 3 deg. The total cost is estimated as $1,491,200.

Plans for Potomac River Canal Before Army Engineers

Plans to connect the Ohio River with the Potomac River, thereby furnishing a direct connection between the Atlantic Ocean and the Ohio and Mississippi valleys, are being studied by the Engineer Corps of the United States Army. The plans include the canalization of the Potomac River from Great Falls, near Washington, to its headwaters, a connection of that point, by means of another canal, with the headwaters of the Monongahela River near Pittsburgh, and the improvement of the Monongahela at its confluence with the Ohio. The proposed canal would traverse western Maryland and western Pennsylvania.

States Ask for Authorization of Red River Bridge Project

The first of the contemplated Red River bridge bills has appeared in the House of Representatives in the form of a measure offered by Representative Johnson, of Oklahoma, authorizing the states of Texas and Oklahoma to construct and operate a free highway bridge over the river between Terral, Okla., and Ringgold, Tex. The Texas delegation in Congress has been asked by Governor Moody of that state to support the bill. Private interests operating toll bridges in the vicinity are opposing the establishment of the program.

Brief News

A NEW PASSENGER STATION at Windsor, Ont., near the Windsor-Detroit tunnel terminal will be built by the Canadian Pacific Railway. Several sites are being considered.

INTERCONNECTION between producers of electricity in Austria, Czechoslovakia, Switzerland, Germany and Luxemburg will be the subject of negotiations to be inaugurated early this year with the object of simplifying the transmission of energy across frontiers.

PERMISSION TO UNDERTAKE a hydroelectric development capable of generating 50,000 hp. near the Seiter Rapids on the St. Francois River, Quebec, at an estimated cost of $6,000,000, has been requested of the provincial government by the Southern Canada Power Company.

THE FIRST INTER-REPUBLIC RAILWAY communication in Central America is provided by the completion of the Zacapa-Santa Ana line of the International Railways of Central America, connecting Guatemala and El Salvador. A ceremony in celebration of the event was held Dec. 28 at the point where the railway crosses the border line.

CONSTRUCTION by the Sugar Land Railway, a Missouri Pacific subsidiary, of a 12-mile extension in Fort Bend County, Texas, has been authorized by the Interstate Commerce Commission. The line is to extend westward from Cabell to serve an agricultural area of 25,000 acres. Plans of the Brazos Valley Irrigation Company provide for the irrigation of this section. The cost of construction is estimated at $178,953.

A NEW BRANCH RAILWAY from Cranberry Portage, on the Flin Flon Railway, in Canada, to the Sheritt-Gordon mines at Cold Lake has been completed and turned over to the Canadian National Railways for operation.

CONSTRUCTION of a new water-supply station in Memphis, Tenn., capable of producing 15,000,000 gal. daily has been decided upon by the board of water commissioners of that city. It is estimated that the cost of the plant will be about $1,500,000.

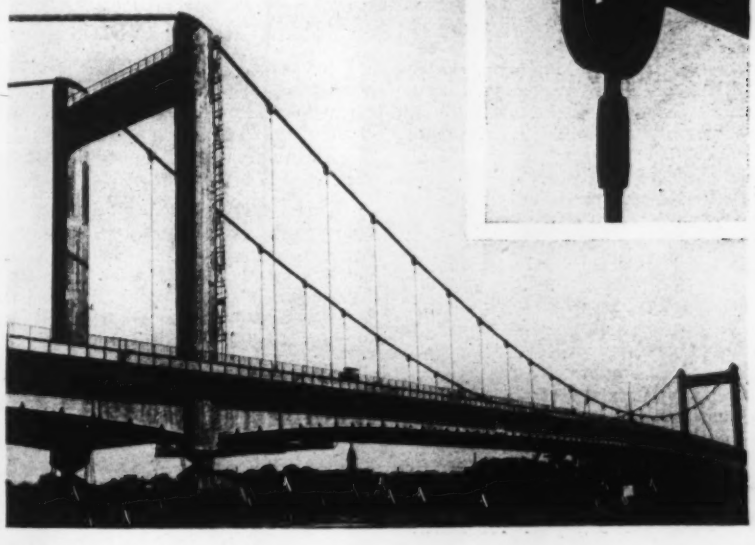
CONGRESS HAS APPROPRIATED $9,740,000 for the erection in Washington of a building to house the United States Supreme Court. A special commission has acquired a site near the Capitol and has approved plans by Cass Gilbert for a structure that will be in keeping with the power and dignity as well as the needs of the country's highest judicial body.

THREE FREE BRIDGES across the Red River will soon be constructed to replace present toll bridges. These will connect Denison, Tex., with Durant, Okla.; Ringgold, Tex., with Terral, Okla.; and Gainesville, Tex., with Marietta, Okla. In addition, the two states have arranged to purchase a fourth bridge between Preston, Tex., and Medill, Okla., and remove toll charges.

NEW SUSPENSION BRIDGE ACROSS THE RHINE AT COLOGNE, GERMANY

The self-anchored suspension bridge connecting Cologne with Mülheim, Germany, the completion of which was noted in *Engineering News-Record*, Nov. 7, 1929, p. 744. The center span is 1,032 ft. long. Each of the two cables consists of 31 locked wire ropes consisting of 277 wires in nine layers.

P. & A. Photos



Long Tunnel Completed in Italy

The last barrier has just been blown down in the great tunnel under the Apennines, through which is to pass the "direttissima" (direct railroad) between Bologna and Florence, Italy. By using this new line travelers from the north proceeding to Florence and Rome will save about two hours.

Work on this tunnel, which was begun in 1913 but was interrupted by the war, was recommenced in 1920. The tunnel is 18,510 meters in length and runs in a straight line. The steepest gradient is 5.77 in 1,000. In length this Apennine tunnel is exceeded only by that of the Simplon (by about 1 km.). During the work of construction 1,488,000 cu.m. of soil was excavated and 423,000 cu.m. of wall was built; 1,300 workmen were on an average employed daily in the inside of the tunnel and 550 in the outside workshops. In the rock-blasting operations 967 tons of dynamite was used. The whole of the new Bologna-Florence railroad will cost approximately $57,500,000.

Virginian Railroad Extension Recommended by Examiner

Extension of the Virginian Railroad to connect its present terminus at Deepwater with the Kanawha & Michigan Railway of the New York Central system is recommended in a report by Examiner R. R. Moser, of the Interstate Commerce Commission. This extension will involve the construction of 1 or 2 miles of track and a bridge across the Kanawha River in Fayette County, West Virginia. Two alternative locations for the bridge have been proposed, one involving the construction of 1.04 miles of track and a bridge 1,845 ft. long at an estimated cost of $786,700, and the other 1.94 miles of track and a bridge 1,600 ft. long at a cost of $1,200,000. The bridge project is opposed by the Chesapeake & Ohio Railroad, which now has an application before the commission to acquire control of the Virginian. In the recently published consolidation plan of the Interstate Commerce Commission the Virginian is allocated to the New York Central.

Michigan Engineering Conference Set for Jan. 30-31

In connection with the annual Michigan Engineering Conference, to be held at Ann Arbor, Mich., on Jan. 30 and 31, the Michigan Engineering Society will celebrate its 50th anniversary. Among the speakers who have accepted places on the program are Robert P. Lamont, Secretary of Commerce; Gov. Frank C. Emerson, of Wyoming; W. A. Starrett, of New York; Dr. Ruthuen, president of the University of Michigan, and H. C. Sadler, dean of engineering and architecture at the university. The general theme of the conference will be "the engineer's contribution to the art of living."

WASHINGTON NOTES

By Paul Wooton
Washington Correspondent

Sewage Disposal and Navigation at Chicago—New Railway Lines Proposed in East and Southwest

CONFLICTING reports have been given out as to what action the War Department intends to take about renewing the permit for the Chicago diversion that expired Dec. 31. As the result of events during the last week, however, it seems certain that the permit will be renewed. The uncertainty about the situation lies in whether or not the amount of the diversion will be cut.

At the time of this writing a new permit has been drafted by the army engineers and is being considered by the Secretary of War. This permit, which has been approved by the Chief of Engineers, cuts the amount of diversion from the present 8,500 sec.-ft., it is understood. While it is not known to exactly by what extent the diversion is lessened, it is believed that it is to 7,250 sec.-ft. This opinion is substantiated by the fact that the War Department, when it first approved the diversion of 8,500 sec.-ft. five years ago, made the stipulation that the amount would have to be reduced to 7,250 sec.-ft. at the end of 1929. The new permit will apply only until July 1, when the withdrawal of water from Lake Michigan is drastically reduced by the recommendations of the special master's report to the Supreme Court.

In commenting on the situation the Secretary of War has agreed that administrative action is necessary pending final action by the Supreme Court. It was thought for a while that, as long as the Supreme Court has taken charge of the disposition of the case, what relief that could be granted in the way of a renewal of the permit would have to come from that body.

Navigation Requirements

The problem of diversion of water from Lake Michigan in connection with Chicago's sewage having been disposed of by the Supreme Court, the federal authorities are now confronted with the matter of diversion for navigation. The Supreme Court's decision did not mention diversion for navigation as coming under its ruling. While the proponents of the Lakes-to-the-Gulf waterway do not particularly desire to raise the question at this time because of the unfinished state of their project, the army engineers already are confronted with the problem.

The War Department is charged with the responsibility of protecting the interests of navigation on all waterways. The Chicago River and its south branch are now under the jurisdiction of the federal authorities in so far as navigation is concerned. In connection with serving the interests of those engaged in commerce on the Chicago River, the army engineers find it difficult to separate the diversion of water for sanitary purposes and diversion for navigation. It is admitted that nothing like the present diversion of 8,500 sec.-ft. is necessary for navigation alone. At the same time it is realized that the extremely unsanitary conditions that would prevail if sufficient water were not withdrawn to flush down the sewage and sludge would seriously endanger the lives of those engaged in navigation. Following this line of reasoning, it is contended by some that the War Department can properly claim a certain interest in sewage disposal.

Eastern Trunk Route Planned

In conjunction with its plan to create a new, short, low-grade line between Chicago and New York and Philadelphia, the Baltimore & Ohio has applied to the Interstate Commerce Commission for authority to acquire control of the Buffalo & Susquehanna Railroad by purchasing a majority of its capital stock at a price of $90 per share for both preferred and common. The commission now has before it for final disposition the application of the B. & O. to acquire control of the Buffalo, Rochester & Pittsburgh Railway, now controlled by the Van Sweringens. Both roads are allocated to the B. & O. in the commission's consolidation plan. To create its new line, the B. & O. proposes to use 74 miles of the B. R. & P. from Butler to B. & S. Junction (5 miles from Dubois, Pa.) and about 50 miles of the Buffalo & Susquehanna to Driftwood, Pa., from which point the line would proceed, either by new construction or the use of existing rails, to Williamsport, Pa., thence over the Reading and Jersey Central to New York and Philadelphia.

Southwestern Railway Construction

New construction in the Texas Panhandle by the Frisco and Rock Island would furnish these systems with a shorter route than is now available to them from northern Texas and southwestern Oklahoma to Fort Worth and Dallas. The joint plan of the two systems has been recommended for the Interstate Commerce Commission's approval by Examiner Thomas F. Sullivan. The Frisco is planning to build a north-and-south line between Seymour, Baylor County, and Vernon, Wilbarger County, 44 miles. The cost of the line, laid with 75-lb. rail without ballast, is estimated at $1,709,744. The Rock Island's new line would extend from Beaver Creek, a point on the Frisco's Seymour-Vernon project, northwest up the Red River valley, via Wellington, to Shamrock, Wheeler County. The cost is estimated at $4,217,854. The track would be laid with 80-lb. relay rail, using 6 in. of ballast.

The Burlington's plan to build from Childress north through Wellington to Pampa, Gray County, was disapproved in the examiner's report on the ground that construction of 110 miles of road at a cost of $4,276,000 to reach the oil and gas field between Shamrock and Pampa, now served by two lines of the Sante Fe, is not justified.

The examiner's report recommends construction by the Santa Fe of an extension from Heaton, Gray County, southeast 8.7 miles to a point east of Lefors to serve carbon black and casinghead gasoline plants of the Coltexo Corporation. The cost of the proposed line is estimated at $375,000.

Construction of a 69-mile line from Fredericksburg, Gillespie County, to Brady, McCulloch County, Texas, is recommended in a proposed report by Examiner J. S. Prichard. The line would form a part of a new direct route between northwest and southeast Texas, desired by business interests of San Antonio and San Angelo. As presented to the commission, the company's plan embraced construction of a line from Eden, Concho County, to San Angelo, 44 miles, but the examiner recommended that consideration of this part of the project should be deferred until the new road definitely determines whether arrangements can be made with the Colorado & Santa Fe to operate over its line between Brady and Eden or whether it will be necessary to construct a new line between those points, which are 32 miles apart. Construction cost of the two lines is estimated at $5,227,665.

Great Increase Likely in Federal Aid

In an effort to do its part to meet the desires of the administration to speed up road construction the committee on roads of the House of Representatives, after unprecedentedly brief hearings, reported favorably the bill providing for an increase of federal aid to $125,000,000 for the fiscal year beginning June 30, 1931, and for the fiscal year beginning June 30, 1932. It also provides an authorization for an additional $50,000,000 for the next fiscal year. Plans already have been made for the House to take up the bill before the middle of January. It is certain that it will be passed perfunctorily and sent to the Senate, where no extended delay is expected.

Personal Notes

Leonard C. L. Smith has been appointed engineer member of the newly created Sanitation Commission of New York City. He is a graduate of New York University and a member of the American Society of Civil Engineers.

A. H. Moore has been named city engineer of Indianapolis under the incoming administration. He was formerly a member of the firm of Jesup & Moore and is credited with directing the largest improvement program in the city's history.

R. G. Cone has been appointed general manager of the Tacony-Palmyra Bridge Company, owner of the toll bridge opened last August between Philadelphia, Pa., and Palmyra, N. J. Mr. Cone previously was resident engineer on the Ambassador bridge at Detroit for Modjeski & Chase, the con-

sultants, and before that was resident engineer on the construction of the central section of the Delaware River bridge between Philadelphia and Camden, N. J.

HUGH R. CARTER, formerly of the Arkansas State Highway Department, has been appointed engineer of the Fifth-Sixth-Ohio streets paving district of Pine Bluff, Ark.

W. H. MIESSE has been appointed engineer of maintenance-of-way of the Evansville, Indianapolis & Terre Haute Railway, with headquarters at Washington, Ind.

E. J. BAYER has been appointed division engineer of the Indianapolis terminal and Springfield division, Cleveland, Cincinnati, Chicago & St. Louis Railway. He succeeds J. W. Burt, retired.

HARRY N. JENKS has entered the consulting engineering field on the Pacific Coast in conjunction with Clyde C. Kennedy, with offices in San Francisco. They will specialize in sanitary engineering.

JOHN L. KLORER, commissioner of public property of the city of New Orleans, has been selected as the new chief engineer of the Orleans Parish Levee Board. The appointment becomes effective next May at the expiration of Mr. Klorer's tenure as commissioner.

LLEWELLYN N. EDWARDS, of the U. S. Bureau of Public Roads, sailed on the "Olympic" from New York on Dec. 20 for the British Isles. The special object of his trip is to study British methods and practices in the design and construction of bridges and highways.

CARTER B. COOKE recently accepted a position with the Florida State Road Department as location engineer on highway and bridge locations. Mr. Cooke previously was with the city of Miami, and for the past year was resident engineer on the construction of the four new bridges recently completed by the city over the Miami River.

DUDLEY F. HOLTMAN has resigned as construction engineer of the national committee on wood utilization of the U. S. Department of Commerce and will establish himself in Chicago as a consulting engineer specializing in wood construction. He will be succeeded by Nelson S. Perkins, a graduate in civil engineering from Cornell University, who assisted Mr. Holtman in the preparation of the committee's wood construction manual.

CHANGES in the personnel of the engineering department, American Bridge Company, have been announced as follows: For the Eastern division, R. R. Graham becomes assistant division engineer at New York City; F. L. Castleman succeeds him as engineer of the Trenton, N. J., plant, and H. B. Castleman becomes acting engineer of the Pencoyd plant. In the central division, J. E. Elliott becomes assistant division engineer, with headquarters at Pittsburgh. J. W. Small succeeds him as engineer of the Ambridge plant. In the Western division, F. W. Dencer is appointed assistant division engineer, with headquarters in Chicago, his former position as engineer of the Gary, Ind., plant being taken by C. J. Kennedy.

Society Calendar

AMERICAN CONCRETE INSTITUTE, Detroit; annual convention, New Orleans, La., Feb. 11-13.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago; annual meeting, Chicago, Ill., March 11-13.

AMERICAN ROAD BUILDERS ASSOCIATION, Washington; annual convention, Atlantic City, N. J., Jan. 11-18.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; annual meeting, New York City, Jan. 15-17.

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago; annual meeting, Seattle, Wash., Jan. 28-30.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington; annual convention, New Orleans, La., Jan. 20-22.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, Trenton; annual convention, Syracuse, N. Y., Feb. 19-21.

ENGINEERING INSTITUTE OF CANADA, Montreal; annual convention, Ottawa, Ont., Feb. 12-14.

NATIONAL CRUSHED STONE ASSOCIATION, Washington; annual convention, Cincinnati, Ohio, Jan. 20-23.

NATIONAL SAND AND GRAVEL ASSOCIATION, Washington; annual meeting, Memphis, Tenn., Jan. 28-30.

FLORIDA SECTION, American Society of Civil Engineers, at its annual meeting Dec. 20 in Jacksonville elected Gilbert A. Youngberg president and Ralph E. Spaulding secretary-treasurer.

ILLINOIS SOCIETY OF ENGINEERS will hold its 45th annual convention Jan. 22-24 at East St. Louis. Seven technical sections will meet. W. D. Gerber, Urbana, is acting secretary.

NEW YORK STATE SECTION, American Water Works Association, at a meeting held Dec. 27 in New York City elected J. Walter Ackerman, city manager of Watertown, a director in the national organization. George W. Fuller gave his impressions of the World Engineering Conference at Tokyo, and George A. Cooper described the work of simplification and standardization being done in the waterworks industry by the U. S. Bureau of Standards.

NEW YORK STATE SEWAGE WORKS ASSOCIATION will meet Jan. 18 in New York City. Included on the list of speakers are Arthur S. Tuttle, consulting engineer for the city Board of Estimate; J. Ralph Van Duyne, chief engineer of the Passaic Valley Sewerage Commission; and William Gavin Taylor, consulting engineer, Newark, N. J.

NORTHWEST BRANCH, Associated General Contractors, will hold its eleventh annual convention Jan. 6-8 at Minneapolis.

SOUTH DAKOTA SOCIETY OF ENGINEERS AND ARCHITECTS and SOUTH DAKOTA CONTRACTORS' ASSOCIATION will hold a joint annual convention Jan. 15-16 at Rapid City.

TEXAS WATER WORKS SHORT SCHOOL for water and sewer plant operators will be held Jan. 27-30 at Abilene, Tex. Lecturers on the program include: Jack J. Hinman, Jr., president of the American Water Works Association and professor of sanitation, University of Iowa; Dr. Willem Rudolfs, chief of the department of sewage disposal, Agricultural Experiment Station, New Brunswick, N. J.; Max Levine, professor of sanitary bacteriology, Iowa State College; X. H. Goodnough, state sanitary engineer, Boston, Mass.; F. W. Mohlman, chief chemist, Sanitary District of Chicago; C. G. Gillespie, state sanitary engineer, Berkeley, Calif.; John H. O'Neill, state sanitary engineer, New Orleans, La.; Oscar E. Meinzer, U. S. Biological Survey, Washington; Paul Hansen, consulting engineer, Chicago; and George W. Fuller, consulting engineer, New York City.

UNIVERSITY OF COLORADO, Boulder, will hold its annual Highway Engineering Conference Jan. 16 and 17. Particular attention will be given to topics of interest to highway engineers in the Rocky Mountain region.

Obituary

JAMES CAVERS GILL, Canadian railway builder, died on Dec. 20 at his home in Montreal, aged 57 years. The present Pacific Great Eastern Railway was partly due to his enterprise. Mr. Gill first went to western Canada as a telegrapher, and there found employment with the Canadian Pacific Railway and later with the Grand Trunk Railway. In association with Arthur McEvoy and the late J. C. Keith he built and operated the Howe Sound & Northern Railway, which became part of the Pacific Great Eastern Railway in 1913.

DAVID H. CAMERON, general superintendent of the George A. Fuller Company of Canada, died suddenly in Toronto on Dec. 20. Mr. Cameron was best known for his work on the Royal Bank Building in Montreal and the new Bell Telephone Building on Beaver Halls Hill, Montreal. He was also construction superintendent on the Metropolitan Life Insurance Building in Ottawa and on the King Edward Hotel, Toronto. Mr. Cameron had wide experience in England and Ireland before going to Canada.

R. F. LEEFELD, superintendent of electrical generation for the Los Angeles Gas & Electric Corporation, Los Angeles, Calif., died in that city Dec. 9. A native of Wisconsin, Mr. Leefeld went to California as a young man. From 1909 to 1916 he was chief engineer for the Temescal Water Company at Corona, Calif. For the two years following this he was associated with the Corona Foothill Lemon Company as a diesel engineer, and from June, 1918, to September, 1919, he was in the employ of the Southern Sierras Power Company. During the next two years he served the Arizona Power Company as chief engineer at Clarksdale, Ariz., and in 1921 he joined the Los Angeles Gas & Electric Corporation.

GEORGE BRIDGE LEIGHTON died on Dec. 20 at his home in Hempstead, L. I., after a long illness. Born in St. Louis 65 years ago, Mr. Leighton, after graduation from Harvard in 1888, engaged in construction work on the Los Angeles Terminal Railroad, of which he was elected president two years later. He directed this property for eleven years until its absorption by the Los Angeles & Salt Lake Railroad. Moving to St. Louis, Mr. Leighton assumed the presidency of the Leighton & Howard Steel Company, which in 1903 became a part of a merger of steel companies in the American Steel Foundries. He had also been a director of the New York Railways Company and the Alleghany By-Products Coke Company.

Construction Equipment and Materials

Asphalt Producers Reorganize

Effective Jan. 1, the Asphalt Institute, a new organization made up of producers of asphalt and asphaltic oils, took over the educational and research work formerly conducted by the Asphalt Association, together with the entire executive, engineering, editorial and technical staff of the old association. The Asphalt Institute will continue along broader lines the technical, engineering, educational, scientific and informational activities of the old body, including the low-cost road investigations being made in conjunction with the U. S. Bureau of Public Roads, but will not engage in direct sales. It will also sponsor the annual Asphalt Paving Conference, with the co-operation of other organizations in the field.

Officers of the Asphalt Institute who will serve until the first annual election in March include: chairman of the executive committtee, Joseph S. Helm, Standard Oil Company of New Jersey; president, Leroy M. Law, Shell Petroleum Corporation; secretary, B. L. Boye, Standard Oil Company of New York; managing director, J. E. Pennybacker. Offices will be maintained in New York City.

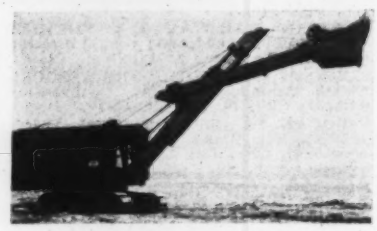
Permanent Builders Exhibit to Be Held in Moscow

In connection with the large program of factory, mill housing and other types of construction now under way in the Soviet Union, a permanent building exhibit is being organized in Moscow, according to the Technical Bureau for Building Industry of the Amtorg Trading Corporation, New York. At the exhibition all types and kinds of building, insulating and roofing materials, as well as models of original structures, will be exhibited. Opportunities are being offered the manufacturers of construction materials and equipment to acquaint Russian companies and engineers with their products by sending samples or models to the bureau for exhibition.

New Developments

Seven New Models Added to Line of Excavators

By adding to its list of products seven additional models ranging in capacity from 1 to 3¼ cu.yd., the Harnischfeger Corporation, Milwaukee, Wis., has placed itself in position to meet requirements for excavating machinery varying from ½ to 3½ cu.yd. in capacity. The new additions are known

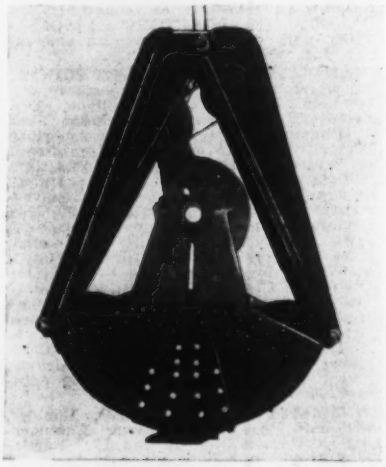


1½-cu.yd. rock shovel

as model 600-A, 1 cu.yd.; 650, 1½ cu.yd.; 700-A, 1¼ cu.yd. rock shovel; 750, 1½ cu.yd., 775, 1½ cu.yd. long corduroy model; 800, 2½ cu.yd.; and 900, 3½ cu.yd. All of these are fully convertible with the exception of the model 775, which has long crawlers for low ground pressure requirements and for this reason can only be used as a dragline, clamshell crane or trench hoe. Gasoline, diesel or electric power is available on all models excepting Nos. 800 and 900, which are supplied in diesel or electric models only. Design features include new internal expanding swing clutches, a fish-belly type of shovel boom with larger cable sheaves and shock-absorbing springs on the power clutch to insure smoother operation.

Clamshell Bucket of New Design

Improved digging power is claimed for a new series of buckets developed by the G. H. Williams Company, Erie, Pa., in which is applied the lever-arm principle with multiple reeving of the closing line and other improved features of construction. The narrow head construction used on older Williams buckets has been made even narrower by attaching one pair of corner bars to the rolled-steel head plate instead of carrying them right up to the bearing pin. A much larger guide sheave is being used and the cable is guarded at the head by improved transverse rollers. The models are available in all sizes from ¾ cu.yd. up.



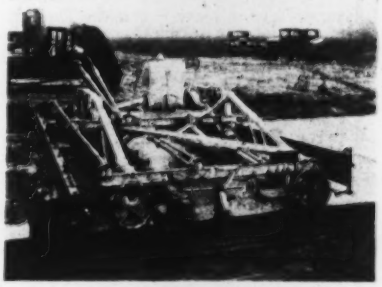
Improved clamshell bucket

Subgrade and Pavement Finish Improved by Two Machines

Exact preparation of the subgrade and smooth finish of the concrete slab are provided for in two new highway machines produced by the Lakewood Engineering Company, Cleveland, Ohio. The power subgrader consists of a framework spanning the road and carried by flanged wheels on the side forms. This carries a cutting roller which acts with a milling action on the grade, forming it to exact depth and cross-section and depositing excess material on the side of the road outside of the forms. Power for all operations is provided by a gasoline motor mounted directly on the framework.

Planing subgrade by power

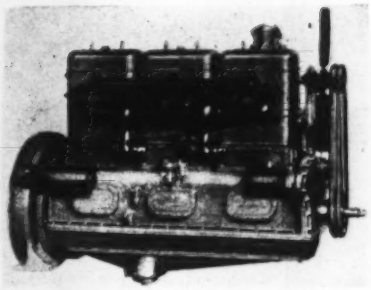
Better concrete finishing is provided by a tandem screed attachment for the usual finishing machine which affords the owner the option of having a single screed machine, a tandem screed or a combined screed and tamper. This machine, also, is mounted on the side forms by flanged wheels and is driven by a self-contained gasoline motor.



Double screed outfit for finishing concrete slabs

Six-Cylinder Motor Produced in Three Sizes

All three sizes of a new series of six-cylinder motors being produced by the Wisconsin Motor Company, Milwaukee, Wis., are interchangeable, the only difference being in the size of the cylinders, pistons and rings. The three models, known as D-2, D-3 and D-4, have bores of 5¼, 5½ and 5¾ in. and a common stroke of 6½ in. Power production at 1,000 r.p.m. is 103, 113 and 125 hp. respectively. Lubrication is force feed throughout, the oil being

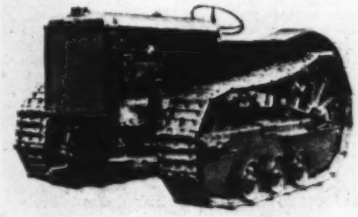


Right side of six-cylinder motor

forced through a drilled crankshaft to all bearings by means of a gear pump. An oil lead is connected with the hollow rocker lever arm, thereby supplying positive lubrication to the actuating mechanism of the valve-in-head motor. A magneto on the left side of the engine provides current for ignition. Cooling is by means of a centrifugal pump with bronze impeller. Two carburetors are used. Auxiliary equipment includes electric starter and generator, oil filter and fuel pump.

New Line of Tractor-Operated Equipment Announced

Tractors, road graders and rollers, snow plows, power shovels, scrapers, bulldozers, backfillers, loaders, hoists, arc welders, cranes, pipe-handling



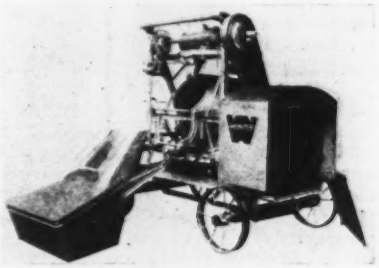
Tractor with crawler equipment

booms, locomotives, stump pullers, trailers and street sweepers are included in a complete line of tractor-powered road-building and construction equipment announced by the United Tractor & Equipment Corporation, Chicago, Ill., a new organization of equipment manufacturers and distributors. All equipment is designed around the United industrial tractor, manufactured by the Allis-Chalmers Manufacturing Company. This tractor is available either as a rubber-tired or a crawler unit. It is powered by a heavy-duty four-cylinder 4½x5-in. motor which develops full power at 1,200 r.p.m. Lubrication is by means of a gear-driven oil pump which leads to all main bearings, connecting rod bearings and pistons. The transmission, of the automotive type, provides four forward speeds and reverse. Other equipment includes an air cleaner and an oil purolator.

Center control grader

One-Bag Concrete Mixer Has Many New Features

Full spring mounting, Timken bearings, automatic skip bumper, power hoist, roller-bearing wheels and inclosed gears and chain feature a new one-bag Wonder concrete mixer announced by

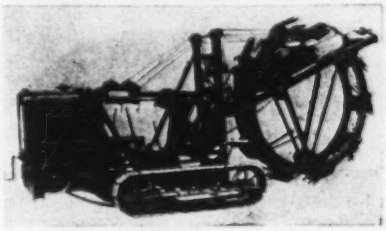


One-bag mixer with gasoline power

the Construction Machinery Company, Waterloo, Iowa. Additional equipment which can be fitted if desired includes a batch meter, with or without counter, an auxiliary hoist, crosswise trucks and rotary water pump. A variety of power units is available: single-cylinder, horizontal or vertical; or multiple-cylinder, hopper or radiator-cooled gasoline engines; or electric motor.

Compact Wheel-Type Digger

With a digging range from 0 to 5½ ft. in depth and up to 23½ in. in width, the Cleveland baby digger, manufactured by the Cleveland Trencher

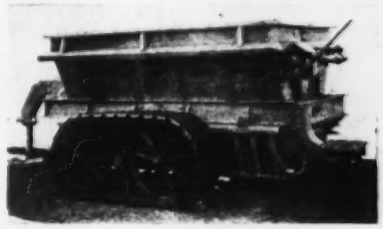


Crawler-mounted wheel-type digger

Company, Cleveland, Ohio, weighs less than 4 tons. The machine is mounted on full crawlers to insure flexibility. The controls are so situated that the operator can at all times see both the work he is doing and the other parts of the machine. Digging depth is controlled through a planetary-type transmission with single lever permitting ½-in. adjustment. A specially built trailer for moving the machine from job to job makes it economical to use this unit where expensive hand labor would otherwise be necessary.

Heavy Dump Wagon Mounted on Crawler Treads

To round out its line of dirt-handling equipment the Western Wheeled Scraper Company, Aurora, Ill., has added to its



Dump wagon mounted on crawler treads

line a new wagon with a capacity of either 5 or 7 cu.yd. which carries the entire load on Athey truss wheels of the crawler type. The larger model, because of its greater height, is provided with a flare board on one side for use with elevating graders. A single pair of bottom-dump doors is provided, operated by a lever. Connection of a series of units in a train is made possible by the addition of a rear drawbar casting to which a second wagon can be attached, the hauling strain being taken by the side channels of the frame.

Truck-Mounted Rotary Snow Plow Driven by Two Motors

Flexibility in operation under varying snow conditions is provided for in a heavy snow-handling truck developed by the Rotary Snow Plow Company, Minneapolis, Minn., in conjunction with the Four Wheel Drive Auto Company, of Clintonville, Wis. Two motors are mounted on the F.W.D. truck chassis in such a manner that either may be used for propulsion. In deep snowdrifts the rear rotor is used to drive the truck, leaving the full power of the forward motor available for operating the rotors of the snow plow. When the snow is not exceptionally deep, the rear motor is not used, and the truck and snow plow rotors are are driven by the forward motor alone. The second motor, mounted on the rear of the truck, is so arranged that it can easily be removed, leaving the truck ready for other work.

Advantages of the double power unit are that the speed at which the rotor operates is independent of the speed of the truck and of the gear ratio in which

Heavy snow plow driven by two motors

it is operated. With a single motor driving both truck and plow, a large and uneconomical engine is necessary, and it is frequently necessary to slip the clutch in

order to give the rotors of the snow plow an opportunity to accelerate and clear away especially heavy drifts.

Controls in the cab of the truck include double ignition switches and starter buttons, an extra clutch pedal, two transmission levers, and a safety device permitting only one of the motors to be used at a time to propel the truck. The foot accelerator is connected to the carburetor of the rear motor, while the hand throttle controls the carburetor in the forward motor.

Wheels of Heavy Trailer Carried on Individual Axles

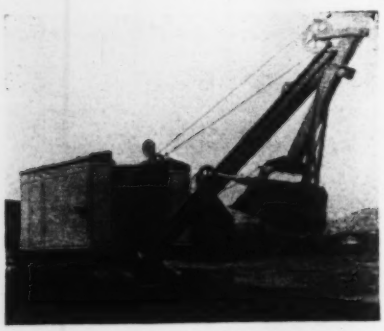
Unique mounting of the rear wheels of a new arch-girder trailer developed by the G. H. Williams Company, Erie, Pa., results in constant contact of the four wheels with the roads regardless of roughness. Each wheel is mounted

Heavy-duty trailer

on a short individual axle supported at both ends without any overhang. The wheels are carried in pairs in cast-steel frames pivoted on a longitudinal axle, giving free swiveling action. Ample clearance is provided to prevent fouling with the frame of the trailer. In front, the wide arch girders are supported by two extra-heavy stiffening members. The main frame itself is of improved design with sturdy cross-members to give extra strength. Oversize Timken bearings are used to reduce friction.

Full-Revolving Pull Shove. of ¾-Cu.Yd. Capacity

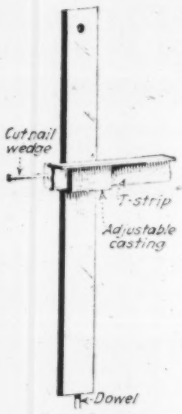
Skimmer or pullscoop buckets of ¾-cu.yd. capacity may be used with the new model 17 full revolving shovel manufactured by the Keystone Driller Company, Beaver Falls, Pa. This machine is equipped with a 40-ft. crane boom for use with a ¾-yd. clamshell and can also be furnished with back scoop, dragline or similar attachment.



¾-yd. excavator with pullscoop bucket

Level Concrete Slabs Assured by Simple Screed Gage

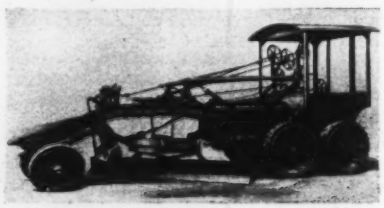
Striking off concrete slabs to the desired level is facilitated by the use of an adjustable screed gage made by the M&M Wire Clamp Company, Minneapolis, Minn. This consists of a 16-in. vertical bar ½x1¼ in. fitted at the base with a ⅜-in. dowel, upon which is fitted a malleable casting grooved to hold an ordinary T-bar The casting is held at the desired height by means of a wedge made of an ordinary 20-penny cut nail. Gages are set by boring ⅜-in. holes into the form settings, into which are driven the dowels at the foot of the vertical strips. They should be placed approximately 5 ft. apart in rows about 10 ft. from center to center. After the gages are in position, the T-strips are laid in the grooves to support the screed or straight-edge, which is zigzagged across the bars in order to pass the extension of the gage. The gages can be pulled out by hand if the slab is not too deep. A hook can be used if desirable, passing this through a hole provided in the top of the vertical strip.



Screed gage

Motor Grader Driven by Built-In Power Plant

Instead of being built around a standard tractor, the new model 12½-25 dual-drive motor grader brought out

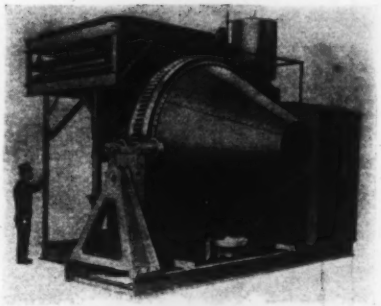


Motor grader with four-wheel drive

by the Austin-Western Road Machinery Company, Chicago, Ill., is powered by a six-cylinder Buda motor built solidly into the frame. This drives through a four-wheel construction of great flexibility. The grader incorporates the usual leaning wheel feature found in machines of this make and is controlled by a single operator.

Large Mixer Designed for Central Plants

Proportioning by weight is provided for in the design of a new 84-S tilting mixer manufactured by the C. L. Smith Company, Milwaukee, Wis., and de-



84-S mixer with Weigh-Mix Equipment

signed particularly for central mixing plant use. The unit has a capacity of 3 cu.yd., and is provided with ball and roller bearings and a new design of power tilt unit. Aggregates are proportioned by means of the Weigh-Mix unit used on other Smith mixers, which results in a saving in headroom.

New Publications

Heater—BUFFALO FORGE COMPANY, Buffalo, N. Y., has issued a leaflet describing the Wetboy, a unit heater which washes and humidifies air.

Asphalt Plants — MERRIMAN ASPHALT PLANT, INC., Lima, Ohio, has issued a folder describing stationary and portable asphalt plants and accessories.

Welders — LINCOLN ELECTRIC COMPANY, Cleveland, Ohio, has issued individual specification sheets describing welding equipment manufactured by the company.

Welding in Aviation—LINDE AIR PRODUCTS COMPANY, New York City, in a 6-p. illustrated leaflet, "Airplane Fuselage Welding," gives a short course for welders in airplane construction and also directions on how to weld duralumin.

Chlorine — HOOKER ELECTROCHEMICAL COMPANY, Tacoma, Wash., is distributing an 8-p. bulletin on the uses, physical properties and methods of handling chlorine in industry.

Lumber Specifications—SOUTHERN PINE ASSOCIATION, New Orleans, La., discusses in great detail the effect of moisture content in lumber in a 12-p. bulletin recently issued. This includes the provisions of the standard moisture content specifications for Southern pine recently adopted.

Bridges—AMERICAN INSTITUTE OF STEEL CONSTRUCTION, INC., New York City, in a 48-p. illustrated booklet, "The Superiority of the Steel Bridge," gives arguments in favor of the use of steel in bridge construction. Many fine illustrations are included, showing notable bridge structures both in this country and abroad.

Lighting and Ventilation—DETROIT STEEL PRODUCTS COMPANY, Detroit, Mich., gives a non-technical presentation of the methods used to predetermine the daylighting and airation of industrial building in two booklets, "Industrial Daylighting" and "Industrial Airation," containing the results of several years of experimentation by engineers of the company in co-operation with the department of engineering research of the University of Michigan. The subject matter is presented in clear and non-technical form.

Directory—AMTORG TRADING CORPORATION, New York City, has compiled a comprehensive catalog of American industry and trade for distribution in the Soviet Union. The catalog contains 1,000 pages, of which 676 are devoted to advertisements of 475 leading American manufacturing firms. A section of more than 150 pages contains an alphabetical list of American machinery and equipment of possible interest to the Soviet market, together with the names of the principal firms manufacturing this equipment. It is planned to distribute 10,000 copies of this catalog throughout the Soviet Union.

The Business Side of Construction

December Awards Lowest in Value Since March, 1925

DECEMBER contracts for engineering construction totaled $161,208,000, compared with $237,097,000 in December, 1928, and is the lowest monthly total since March, 1925. The drop from November was 32 per cent, compared with 4 per cent the year before.

The decline is in both public and private construction, but is most severe for private except in the case of industrial buildings. Total private work dropped 43 per cent, public 11 per cent. In millions of dollars, commercial buildings dropped from 95 in November to 54 in December, unclassified structures from 156 to 89. Industrial buildings were the same for both months. All sections except New England and the Middle Atlantic states reported values lower than those of December, 1928.

The total for the year is $3,950,000,000, compared with $3,579,000,000 in 1928. This is a gain of 10 per cent, compared with a gain of 9 per cent in 1928. The gain is confined to private work, chiefly buildings, the value of public construction being 5 per cent under that of the preceding year. The building division amounts to 64 per cent of the engineering construction total, compared with 62 per cent in 1928. Private unclassified structuers doubled in value. Public unclassified amounts almost to exactly the same as the year before. The water-works total is half that of 1928, and is explained by the $42,000,000 Yonkers-Brooklyn water tunnel awarded in the latter year. Sewers show a definite though not serious decline. Public bridge contracts amount almost to exactly the same as in 1928, the difference in favor of 1929 being only a million; private bridges gained $5,000,000, or 15 per cent; for all bridges the gain is 4.5 per cent. Throughout the year street and road lettings were handicapped by a slow start. At the end of the first quarter the handicap was 50 per cent. The total for the year is $539,000,000, or only 12 per cent under the 1928 record, and is 3 per cent above the 1927 total. Federal work is 49 per cent above 1928.

All sections of the country gained except the Middle West, which reported $747,000,000 worth of contracts, compared with $809,000,000 in 1928, a decrease of 8 per cent. This changed its rating from 23 per cent of total engineering construction in 1928 to 19 per cent in 1929. The only other change in rating was in the Middle Atlantic states—from 39 per cent to 43 per cent in 1929. New England remained 6 per cent; the South 8; between the Mississippi and the Mountains, 15, and the eleven Far West states 9. Canada reports a gain of 8 per cent.

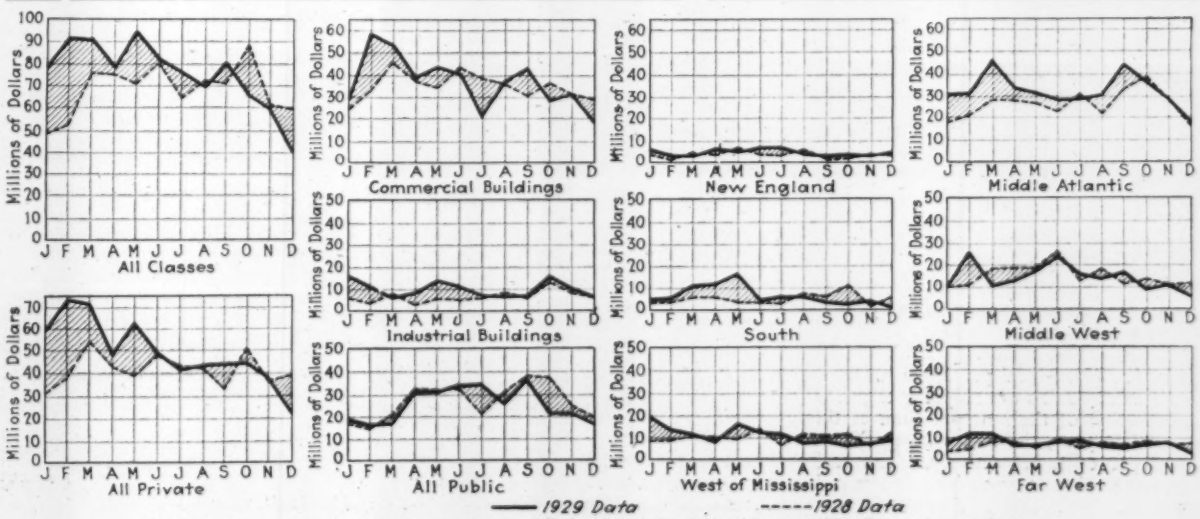
November Financing

As a result of the stock market drop, new capital issues for November total only $281,000,000, compared with $903,000,000 the year before. Municipal bond awards total $84,000,000, compared with $171,000,000 for November, 1928. In this connection it should be noted that last year's figure included $55,000,000 placed by New York City, whereas this year New York deferred its financing until December, when $65,000,000 of new bonds were sold. A noteworthy feature is the collapse of investment trust, trading and holding company financing. In millions of dollars this figure in September was 643, in October 200, and in November 3.4.

For the eleven months of 1929 new capital totaled $9,550,000,000, a gain of

VALUE OF CONTRACTS AWARDED IN THE UNITED STATES AND TOTAL FOR CANADA, DECEMBER, 1929
Thousands of Dollars (000 omitted)

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States December 1929	United States Year to Date 1929	United States Year to Date 1928	Canada December 1929
Water-works		$1,843	$49	$702	$523	$106	$3,223	$48,617	$99,437	$50
Sewers	$350	1,546	98	1,508	344	357	4,203	87,674	100,732	112
Bridges	50	1,393	261	1,326	2,133	1,250	6,413	135,588	130,203	172
Excavations, etc.	25	13	25	66	4,036	29	4,194	31,570	37,734	554
Streets and roads	1,109	4,162	3,255	2,628	10,215	2,224	23,593	539,352	615,279	547
Industrial buildings	11,262	6,309	495	2,120	3,422	2,205	25,813	547,313	355,187	4,021
Commercial buildings	3,429	45,556	1,890	7,740	9,854	6,175	74,645	1,975,987	1,862,418	6,295
Federal government	25	570	617	31	1,400	388	3,031	103,901	69,815	
Unclassified	703	6,533	165	4,468	2,989	1,235	16,093	480,313	310,775	1,819
December, 1929, 4 weeks	16,953	67,925	6,855	20,589	34,916	13,970	161,208			13,570
November, 1929, 4 weeks	13,808	108,534	17,310	41,781	29,699	26,536	237,668			8,853
December, 1928, 4 weeks	13,273	66,640	24,051	51,210	53,550	28,373	237,097			20,829
Year, 1929	237,938	1,680,502	329,984	747,032	583,487	371,372		3,950,315		189,248
Year, 1928	222,237	1,383,111	290,525	809,463	537,733	335,511			3,578,580	175,599



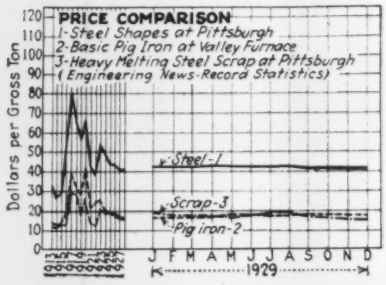
Contracts awarded—Average week per month—Total U. S. by classes—All classes by sections

38 per cent over 1928. Of this $1,122,000,000 was for municipal financing, a decrease of 9 per cent.

Prices Gaining Strength

Construction materials prices have assumed a firmer tone since the close of the old year. This is particularly true of pine timbers, cement, brick and cast-iron pipe. Severity of competition, on the other hand, has adversely affected the fir-timber market in the East, while steel buying is sluggish with no change expected in the Pittsburgh base.

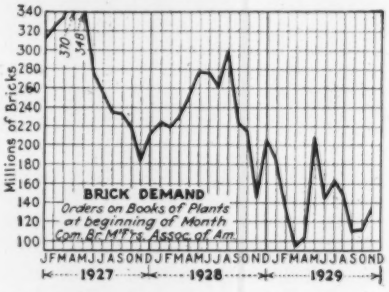
Lumber—With reserve stocks at 2,900,000,000 ft. for the softwood mills of the country, or 9.8 per cent greater than they were a year ago, a strong urge is being felt among lumbermen to cut production even at risk of increasing unit cost of output. The weekly rate of cutting is now about 206,000,000 ft., 7.2 per cent under that of a year ago. A reduction of 25 per cent in output, it is estimated, would result in an increase of $2 per 1,000 ft. in manufacturing costs but would also pave the way to subsequent price advances which might more than outweigh the higher cost of production. Dealers have quite generally given up the idea of price cutting as a means of encouraging lumber consumption. Stocks in dealers' yards have shrunk considerably during the last month,



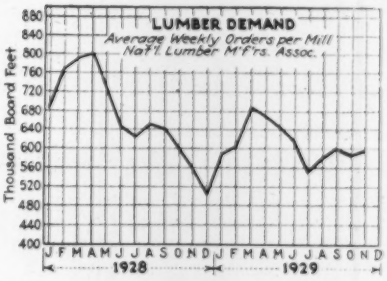
owing to easing of pressure-selling on the part of wholesalers. In the New York area, No. 1 hemlock is being offered at the same prices as No. 2 and at times No. 3 Douglas fir, causing demoralization of the latter's market. Cutting exceeds demand by the following percentages in the various species: California pine, 40; Northern hemlock, 35; Western pine, 30; North Carolina pine, 30; Northwest fir and hemlock, 25; Northern hardwoods, 20; California redwood, 20; Southern pine, 10. In Northern pine, however, the demand is 175 per cent greater than the output. The average delivered prices of 3x12 timbers are as follows: pine, Jan. 1, 1930, $65.06; Dec. 1, 1929, $64.74; Jan. 1, 1929, $60.91. Fir, Jan. 1, 1930, $50.07; Dec. 1, 1929, $51.18; Jan. 1, 1929, $47.76 per 1,000 ft.b.m.

Cement—Mills are shipping a greater proportion of their output than at this time last year, the ratios being 80 and 79.3 per cent, respectively. The ratio of production to capacity, however, is now 66.6 per cent, as against 77.4 a year ago. Mill stocks are 2.8 per cent greater than at this time last year, with prospects of steady seasonal rise until April. Dealers look for improvement in demand early in 1930, owing to easier rates on money for construction purposes. The average mill prices of cement, without bags, are as follows: Jan. 1, 1930, $1.73; Dec. 1, 1929, $1.69; Jan. 1, 1929, $1.80 per barrel.

Brick—The rate of demand is now about 133,000,000 a month, which is 8 per cent under requirements of a year ago. Deliveries on old orders, however, are comparatively heavier than at this time last year. Dealers' observations of possible consumption during the slack period between now and spring point to a pick-up in volume of buying. In the New York district,

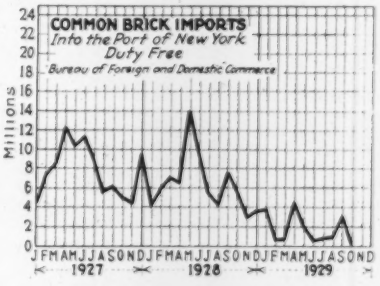


particularly, the price outlook is for an advance of about $1 over the present wholesale rate of $11 per thousand. In all probability New York will face a common brick shortage in the spring. Reason for this is seen in the fact that about 40 plants have gone out of business during the last two years in the Hudson River district. Of the 26 remaining plants, all of them modernized and well equipped, not more than six are now in operation, with a weekly output representing but 30 per cent of requirements normal to this market.



The retarded production would amount to nothing more than the old-time cold weather shutdown were it not for the fact that Hudson River stocks are lower now than in any winter in the history of the industry. Scarcity will undoubtedly support the predicted rise of $1 per thousand at New York. Moreover, manufacturers claim that the cost to place common brick on the New York market is close to $13 per thousand wholesale, which would make the current price of $11 appear below cost. The average delivered prices of common brick are as follows: Jan. 1, 1930, $14.61; Dec. 1, 1929, $14.63; Jan. 1, 1929, $15.04 per thousand.

Cast-Iron Pipe—The mill base at Burlington, N. J., is up $2 per ton ($36) on 6-in. and over, Class B and heavier, compared with prices of a month ago. Prices f.o.b. New York

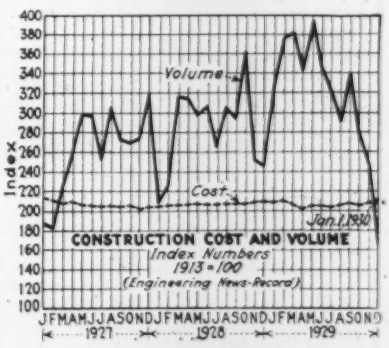


Construction Cost and Volume Index Numbers

E. N.-R. Cost		E. N.-R. Volume*	
Jan., 1930	**208.98**	**Dec., 1929**	**166**
Dec., 1929	209.46	Nov., 1929	245
Jan., 1929	209.40	Dec., 1928	244
Peak June, 1920	273.80	1929 (average)	317
1929 (average)	207.02	1928 (average)	287
1913 (average)	100.00		
1928		1928	
January	203.90	January	208
February	204.65	February	225
March	204.65	March	318
April	206.40	April	316
May	207.00	May	299
June	206.15	June	308
July	206.65	July	266
August	207.29	August	306
September	207.29	September	296
October	207.71	October	363
November	209.46	November	251
December	210.16	December	244
1929		1929	
January	209.40	January	325
February	210.40	February	378
March	207.78	March	382
April	203.40	April	332
May	205.15	May	395
June	205.65	June	347
July	204.77	July	320
August	205.91	August	290
September	207.57	September	340
October	206.32	October	273
November	208.46	November	245
December	209.46	December	166

*Corrected for price change since 1913.

The December drop in volume, 32 per cent, was much larger than seasonal. This has not affected the major materials market, which is actually slightly stronger than a month ago. Wage changes were negligible, and the Cost Index is 0.5 above a month ago.



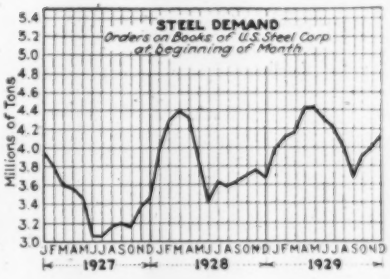
have advanced in accordance with the increase at mill. Oakland, Calif., awarded 119 tons of Class B pipe to the National Cast Iron Pipe Company, Los Angeles, at $37.60 per ton. Throughout December, however, dealers adhered to the quotation of $47@$48 per ton for 6-in. and over, f.o.b. San Francisco, on smaller lots.

Steel—The steel market, normally dull at this season, is too slow to test adequately the current Pittsburgh base of $1.90 per 100 lb. This base was in effect one month ago and also one year ago. Stocks are low and scrap prices have about reached bottom, it is claimed, with the result that improvement in demand is foreseen for the present quarter. Structural orders booked represent a large tonnage volume, but current buying of this item is not notably active. Mill operations are at 63 per cent of capacity, against 81 per cent a year ago. Concrete reinforcing bars are down 20c. per 100 lb., to $2.70, in sales of more than 5 tons, delivered to job in New York. During December galvanized steel sheets dropped 25c. per 100 lb. ($4.50 base), delivered from New York warehouse. Cutting under to $4.25 is reported. This is worth noting because of the fact that galvanized sheets are usually one of the first of the steel items to show price recession.

Building Programs to Relieve About Half of Unemployment

More than half of the principal cities of the country report construction programs for 1930 of sufficient magnitude to absorb existing unemployment among building trades mechanics in those localities. In the remaining cities, however, there is no hope of immediate relief from the depressed condition of the construction industry. It is still too soon perhaps for the effect of Hoover-conference pledges to be felt.

In Chicago, for instance, but 50 per cent of the building mechanics are employed. There are few prospects of change in the situation while the real estate market is crowded with bonds



unloaded before the crash, in order to facilitate purchase of stocks. At the same time adverse conditions did not prevent employers from granting painters an increase of $1 per day, to $14, effective March 1.

Kansas City expects to have a record building program in full swing by April. St. Louis proposes public works, streets, roads, sewers, etc., which will probably exceed in money value the expenditures for 1929. Cincinnati's increase will also be in public construction.

In the Denver district, government work will take the lead in 1930, with a decided slump expected in buildings. Minneapolis builders look for an increase in residential building, but believe the market to be slowing down in demand for structures for commercial purposes.

The problem in Detroit is one of financing rather than a lack of potential construction work. Birmingham expects many new industries to locate within its confines during 1930. Most of the mills in the Birmingham district are well booked ahead in new business for 1930 delivery.

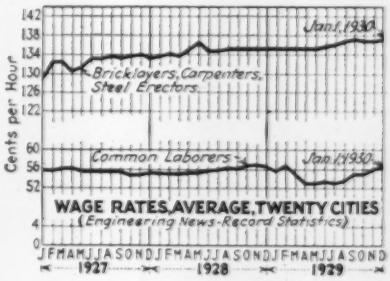
Atlanta's unemployment in all trades is worse than it was a year ago. There is no hope of improvement in this situation, at least in the building trades, before spring. In Baltimore many architects are already busy on work for the new year, which shows improvement over 1929.

Pittsburgh has projects pending sufficient to absorb the idle building trades mechanics before the year is more than a few months old. In Montreal the present volume of contemplated work has never before been exceeded at the outset of the new year. New York's increase will be largely in public improvements and commercial buildings, although in the latter class there is an increasing danger of realizing an excess of vacant stores and offices.

The strike factor has very nearly faded out of the picture, owing to the presence of so much idleness in the building trades, together with the fact that wages have not been cut.

There were but two strikes in December. One was a walkout of pier builders on the Kill van Kull bridge between Bayonne, N. J., and Port Richmond, Staten Island, over the presence of non-union bridge workers on the job. The other was a strike of bricklayers in St. Louis over a jurisdictional disagreement with carpenters engaged in calking work.

With regard to the actual extent of unemployment in the United States at the present time, two authorities—namely, Senator Couzens and the A. F. of L., apparently agree on 3,000,000. The Department of Labor will not commit itself as to the actual number idle until an official census has been taken. It does, however, express the opinion that present unemployment is for the most part due to transients who are normally idle at this time of the year. Replacement of building laborers by machinery is a progressive process and is evidently responsible for some of the unemployment.



Up to the present, replacement has been accomplished by such means as electric saws, hoisting, mixing and conveying devices of various kinds. The bricklayers and plasterers still remain in the manual stage for the reason that machines for doing the work of these crafts have not been universally adopted. The bricklaying machine is practical only in small housing developments where a hundred or more standardized houses are concerned. Thus far the application of plaster by machines has not proved practicable, as in the case of either concrete or paint.

The average skilled building trades wage for January is $1.37 per hour, the same as in December. A year ago it was $1.35. In manufacturing the rate is 67.2c. per hour.

The common labor average for the country is 56.28c. per hour, against 56.53 in December and 55.9c. for January, 1929. In manufacturing the rate is 50.1c. per hour.

CURRENT BUILDING AND CONSTRUCTION TRADES WAGE RATES PER HOUR

Advances since last month are indicated by **heavy type**; declines by *italics*

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor*
Atlanta	$1.25@1.40	$0.60@.70	$0.60@1.00	$0.50	.....	$0.75@1.25	$0.25@.35
Baltimore	1.75	1.00@1.10	1.00@1.37½	.65	$1.00	1.00@1.25	.35
Birmingham	1.50	1.00	1.25	.50	.....	1.25	.20 @ .35
Boston	1.50	1.37½	1.37½	.85	1.27½	1.37½	.45 @ .80
Cincinnati	1.62½	1.40	1.40	1.00	1.40	1.40	.40 @ .60
Chicago	1.70	1.62½	1.62½	.97½	1.62½	1.62½	.97½
Cleveland	1.62½	1.37½	1.37½	.87½	1.10	1.50	.40@.87½
Dallas	1.75	1.12½	1.25	.40 @ .75	1.25	1.25	.35@.50
Denver	1.50@1.62½	1.25	1.25@1.37½	.87½@1.00	.....	1.25	.62½
Detroit	1.56½	1.00@1.25	1.00@1.10	.90	1.00@1.10	1.00@1.25	.37½@.60
Kansas City	1.50	1.25@1.37½	1.25@1.37½	.90	1.25	1.37½	.40@.75
Los Angeles	1.25	1.00	1.00	.....	.....	1.00	.50
Minneapolis	1.25@1.37½	.87½@.95	.87½	.75	.....	1.00	.40@.60
Montreal	1.25	.80	.75	.....	.90	1.00	.35
New Orleans	1.50	.90	1.25	.75	.80@1.00	1.25	.30@.40
New York	1.87½	1.65	1.92½	1.18¾	1.10@1.23¾	1.92½	1.03¾
Philadelphia	1.75	1.12½@1.25	1.02½	.70@1.12½	1.00	1.37½@1.50	.45@.50
Pittsburgh	1.70	1.50	1.43¾@1.56¼	1.12½	.....	1.50	.40@.80
St. Louis	1.75	1.50	1.50 @1.65	1.15@1.25	1.25	1.62½	.40@.87½
San Francisco	1.37½	1.12½	1.12½	.87½	1.12½	1.37½	.68¾
Seattle	1.50	1.12½	1.12½@1.25	1.00	1.12½	1.25	.70

*Minimum rates are for construction other than buildings, non-union.

Current Prices of Construction Materials

Price advances since last month are indicated by **heavy type**; declines by *italics*

Building Materials

PORTLAND CEMENT—Prices per barrel, *without charge for bags*, cash discount not deducted. Prices marked f.o.b. are manufacturers'; others are delivered by truck to contractors:

	Jan. 2, 1930	One Month Ago	One Year Ago
Atlanta	$2.35	$2.35	$2.10
Baltimore	2.40	2.40	2.65
Birmingham	2.40	2.40	2.60
Boston	**2.28**	2.25	2.45
Cedar Rapids (f. o. b.)	2.04	2.04	2.24
Chicago (f. o. b.)	1.85	1.85	2.05
Cincinnati (f. o. b.)	1.92	1.92	2.22
Cleveland (f. o. b.)	1.94	1.94	2.24
Dallas	2.15	2.15	2.15
Davenport (f. o. b.)	2.04	2.04	2.24
Denver	2.61	2.61	2.55
Detroit (f. o. b.)	1.95	1.95	1.95
Duluth (f. o. b.)	**1.94**	1.84	2.04
Indianapolis, (f. o. b.)	1.89	1.89	2.09
Jersey City	2.60	2.60	2.35
Kansas City, Mo.	2.65	2.65	2.20
Los Angeles	2.42	2.42	2.66
Milwaukee (f. o. b.)	2.00	2.00	2.20
Minneapolis (f. o. b.)	2.02	2.02	2.22
Montreal (f. o. b.)	2.05	2.05	1.41
New Orleans	2.65	2.65	2.35
New York	2.30	2.30	2.25@2.35
Peoria (f. o. b.)	2.02	2.02	2.22
Philadelphia	2.10	2.10	2.40
Pittsburgh (f. o. b.)	1.85	1.85	2.04
St. Louis	*2.10*	2.20	2.45
St. Paul (f. o. b.)	2.02	2.02	2.22
San Francisco	2.54	2.54	2.41
Seattle	2.70	2.70	2.70
Toledo (f. o. b.)	2.03	2.03	2.20

Current mill-prices per barrel, in carloads, without bags, f.o.b.:

Alpena, Mich.	$1.65	Limedale, Ind.	$1.60
Buffington, Ind.	1.60	Mason City, Ia.	1.60
Hannibal, Mo.	1.80	Norfolk, Va.	1.90
Houston, Tex.	1.95	North Birmingham, Ala.	1.70
Hudson, N. Y.	**1.85**	Richard City, Tenn.	2.05
Ironton, Ohio	1.50	Steelton, Minn.	**1.75**
Iola, Kan.	1.65	Universal, Pa.	1.60
La Salle, Ill.	1.70	Wyandotte, Mich.	1.70
Lehigh Valley District	1.75		

SAND AND GRAVEL—Per cu.yd., delivered by dealers. Weight of sand, 1½ tons per cu.yd.; gravel, 1½ tons per cu.yd., unless otherwise specified in pounds:

	Gravel		Sand
	1½ In.	¾ In.	
Atlanta, per ton	$2.65	$2.65	$2.00
Baltimore, per ton	2.40	2.60	1.70
Birmingham (2,600 lb. per cu.yd.)	3.00	3.00	2.65
Boston, per ton	1.90	1.90	1.25
Chicago	1.90	1.90	1.80
Cincinnat , per ton	1.65	1.65	1.40
Cleveland (3,000 lb.) (2,700 lb.)	2.60	2.60	2.50
Dallas	2.60	2.60	2.60
Denver (2,700 lb. per cu.yd.)	1.80	1.80	1.30
Detroit (2,600 lb. per cu.yd.)	3.25	3.25	2.75
Kansas City, Mo.	1.85	1.85	1.85
Los Angeles, per ton	2.15	2.15	1.30
Minneapolis (2,800 lb.) (3,000 lb.)	2.40	2.40	1.10
Montreal, per ton	1.25	1.25	1.25
New Orleans (2,700 lb.) (2,500 lb.)	3.75	3.75	2.75
New York	3.40	3.40	2.15
Philadelphia, per ton	2.30@3.15	2.30@3.15	1.50@2.31
Pittsburgh, per ton	2.20	2.20	2.40
St. Louis, per ton	**2.35**	2.25	2.00
San Francisco, per ton	1.75	1.75	1.75
Seattle (3,200 lb.) (2,850 lb.)	1.75	1.75	1.75

Note: New York gravel weighs 2,800@3,000 lb. and sand, 2,700 lb.

CRUSHED STONE—Per cu.yd., delivered by dealers. Weight, 1½ tons per cu. yd., unless otherwise specified in pounds:

	1½ In.	¾ In.
Atlanta, per ton	$2.65	$2.65
Baltimore, per ton	2.75	2.85
Birmingham, Limestone	3.00	3.25
Boston, per ton	2.25	2.25
Chicago, Limestone (2,500 lb. per cu.yd.)	1.90	1.90
Cincinnati, per ton	2.25	2.25
Cleveland, per ton (2,500 lb. per cu.yd.)	2.70	2.70
Dallas (2,500 lb. per cu.yd.)	3.25	3.40
Denver, Granite (2,700 lb. per cu.yd.)	2.50	2.50
Detroit, Limestone, per ton (2,500 lb. per cu.yd.)	3.00	3.00
Kansas City, Limestone	1.85	1.85
Los Angeles, per ton	2.15	2.15
Minneapolis, Limestone (2,600 lb. per cu.yd.)	2.40	2.40
Montreal, per ton	1.90	2.10
New York, Limestone	3.40	3.40
Philadelphia, Limestone, per ton	2.30@3.15	2.30@3.15
Pittsburgh, per ton	2.75	2.75
St. Louis, per ton, (2,400 lb. per cu.yd.)	1.90	1.90
San Francisco, Trap rock, per ton	1.65	1.65
Seattle, (2,700 lb. per cu.yd.)	1.90	1.90

CRUSHED SLAG—Manufacturers' quotations on crushed slag in carloads, per net ton, at plant:

	1½-In.	¾-In.	Roofing	Sand
Birmingham, Ala.	$0.90	$1.15	$2.05	$0.55
Buffalo District	1.25	1.35	2.25	1.25
Cleveland, Ohio	1.15	1.15	.....	.80
Eastern Pa. and Northern N. J.	1.25	1.25	2.00	1.25
Toledo, Ohio	1.25	1.25	1.50	1.25
Western Pennsylvania	1.25	1.25	2.00	1.25
Youngstown District	1.30	1.40	2.00	1.30

HOLLOW TILE—Building tile per block, delivered by dealers to contractors in lots of 2,000 pieces or over:

	4x12x12	6x12x12	8x12x12	10x12x12	12x12x12
Atlanta	$0.072	$0.099	$0.135	$0.181	$0.202
Baltimore	.105	.....	.20	.....	.26
Birmingham	.09	.127	.174	.218	.261
Boston	.086	.113	.155	.20	.26
Chicago	.076	.104	.142	.182	.202
Cincinnati	.066	.09	.125	.16	.18
Cleveland	.064	.088	.128	.171	.19
Dallas	.094	.124	.194	.271	.306
Denver	.0975	.135	.175	.2125	.25
Detroit	.098	.135	.184	.24	.265
Kansas City	.0525	.077	.184	.24	.265
Los Angeles	.085	.122	.175	.232	.285
Minneapolis	.0611	.081	.10605	.1302	.1737
Montreal	.12*	.....	.22†	.....	.....
New Orleans	.086	.118	.16	.212	.256
New York	.0864	.1296	.162	.....	.....
Perth Amboy, N.J. (f.o.b.)	.....	.....	.....	.2388	.2956
Philadelphia	.105	.14	.215	.28	.34
Pittsburgh	.068	.....	.1175	.....	.1726
St. Louis	.078	.104	.145	.175	.21
San Francisco	.108	.156	.255	.....	.....
Seattle	.085	.115	.18	.....	.....

*4x4x12. †8x8x12.

BRICK—Prices delivered by dealers per thousand, are as follows:

	Common	Paving 3x8½x4-in.	F.O.B. 3½x8½x4-in.
Atlanta	$13.50	**$36.00***	**$42.00†**
Baltimore	13.00	40.00	46.00
Birmingham	15.00	**38.00***	**34.00†**
Boston	16.00	43.00	*47.00*
Chicago	12.00	42.00	45.00
Cincinnati	18.00	40.00	45.00
Cleveland	14@16	33.00	36.00
Dallas	13.50	30.00	.....
Denver	11.00	.....	.....
Detroit	15.50	34.50	38.50
Kansas City	*14.00*	.....	.....
Los Angeles	13.00	.....	.....
Minneapolis	12.75	.....	.....
Montreal	20.00	.....	.....
New Orleans	16.50	38.00*	45.00
New York	14@15	45.00	*50.00*
Philadelphia	16.00	40.00	46.00
Pittsburgh	16.00	40.50	45.00
St. Louis	13.00	36.00	40.00
San Francisco	14.50	45.00*	.....
Seattle	14.00	50.00	55.00

*2½x8½x4 in. †3x8½x4.

LIME—Prices delivered by dealers to job:

	Hydrated, per Ton		Lump, per Barrel	
	Finishing	Common	Finishing	Common
Atlanta	$21.00	$13.50	.....	.....
Baltimore	22.00	14.00	$2.55†	.....
Birmingham	22.00	16.00	3.00†	$2.00†
Boston	22.00	15.00	4.00*	3.00*
Chicago	18.00	14.00	18.00‡	1.35†
Cincinnati	15.30	12.70	.....	.....
Cleveland	16.00	12.00	2.50†	2.50†
Dallas	20.00	.....	.....	18.00‡
Denver	32.00	23.75	3.80*	3.00*
Detroit	19.20	14.80	2.20†	2.20†
Kansas City	16.00	12.50	2.75†	2.40†
Los Angeles	25.00	18.00	2.85†	17.00‡
Minneapolis	25.50	21.00	.....	1.70†
Montreal	19.75	.....	.....	15.00‡
New Orleans	.....	.....	2.60†	1.60†
New York	21@23	14@15	4.10@4.20	3.15@3.25*
Philadelphia	22.00	15.00	.....	.....
Pittsburgh	21.00	19.00	2.50†	.....
St. Louis	24.00	18.00	2.75†	15.00‡
San Francisco	27.50	20.00	2.00†	*1.60†*
Seattle, paper sacks	36.00	24.00	.....	2.80†

*Per 280-lb. bbl. (net). †Per 180-lb. (net). ‡Per ton.

CONCRETE BLOCKS—Manufacturers' quotations on standard, 8x8x16-in., hollow, delivered to job, each:

Boston	$0.17@.20	Minneapolis	$0.15
Brooklyn and Queens	.12@.14	New Orleans	.22
Cleveland	.16@.17	Philadelphia	.18@.25
Denver	.22	Pittsburgh	.20
Detroit	.15	St. Louis	.18

SLATE—Roofing, f.o.b., quarry, Bangor, Pa., net, per square:

No. 1 Clear	$9.45@*11.05*
No. 1 Ribbon	*8.10@ 9.24*
Medium Clear	*8.55@ 10.11*

Road and Paving Materials

PAVING STONE—Carloads or cargo lots of granite blocks, 4x8x4-in., dressed, f.o.b:

Atlanta	$3.00 per sq.yd
Baltimore	3.00 per sq.yd.
Boston	135.00 per M.
Chicago, 5 in.	3.25@3.90 per sq.yd.
Cincinnati	110.00 per M.
Cleveland	115@120 per M
Detroit, 5 in.	3.00 per sq.yd.
Kansas City	3.00 per sq.yd.
Minneapolis, 4½x8x5 in	2.80 per sq.yd.
Montreal	104.75 per M.
New Orleans	2.80 per sq.yd.
New York, 5 in., Grade 1, 30 blocks per sq.yd	150.00 per M.
Philadelphia	125.00 per M.
St. Louis, 4x5x8 to 12 in	3.50 per sq.yd
San Francisco	.....

Current Prices of Construction Materials

Road and Paving Materials—Continued

WOOD-BLOCK PAVING—Prices, f.o.b., in carloads:

	Size of Block	Treatment	Per Sq.Yd.
Atlanta	3½	16	$2.25
Boston	3½	16	2.25
Chicago	3½	12	2.10
Cincinnati	3½	16	2.35
Dallas	3½	18	3.90
Kansas City	3½	16	2.75
Minneapolis	3½	16	2.75
Montreal	4	16	4.50
New Orleans	3½	16	2.50
New York	3½	16	2.70
St. Louis	3½	16	2.25

FLAGGING—Alongside dock, New York: Manhattan and Bronx, 4 ft. wide, 24c. per sq.ft.; Queens, 5 ft. wide, 26c. per sq.ft.

CURBING—*New York*: Bluestone, f.o.b. barge, 5x16 in., rough, 90c. per lin. ft., cutting charges extra. *Birmingham*: Limestone, 5x18-in., f.o.b., $1.05 per lin.ft. *St. Louis*: Class "B" straight, 5x16 in., f.o.b., $1.00 per lin.ft.; roundings, $1.50 per lin.ft.

ASPHALT—Manufacturers' quotations per ton in packages (350-lb. bbls. or 425-lb. drums); also in tank-car lots, f.o.b. points listed:

	Package	Tank-cars
Atlanta (Mexican)	$20.40	$16.40
Baltimore (Standard Oil, f.o.b. refinery)	21.75	17.75
Birmingham (Mexican)	27.00	23.00
Boston (Mexican)	23.50	18.00
Chicago (Texas)	23.50	19.30
Cincinnati (Kentucky Rock)	.....	12.30
Cleveland	24.00	20.00
Dallas (Texas)	24.75	.....
Denver (California)	35.00	.....
Detroit (Mexican)	19.72	15.69
Kansas City, Mo. (Texas)	35.00	28.00
Los Angeles ("D" Grade, Calif., f.o.b., El Segundo)	18.00	12.00
Maurer, N. J. (Bermudez)	30.00	.....
Maurer, N. J. (Trinidad)	25.00	.....
Minneapolis, (Stanolind, f.o.b., Twin Cities)	24.10	19.10
Montreal (Imperial)	28.00	21.50
New Orleans (Texas)	24.00	21.00
New York (Texas)	22.50	18.50
Philadelphia (Mexican)	18.00	15.00
Pittsburgh (Standard Oil)	24@26	14@18
St. Louis (Mexican)	21.50	17.50
San Francisco, (f.o.b. refinery, Oleum, Calif.)	18.00	12.00
Seattle, ("D" grade, Calif., f.o.b. Richmond)	18.00	12.00

ROAD OILS—Manufacturers' quotations, f.o.b., in tank cars, 8,000 gal. minimum, per gal.:

Birmingham, 40@50% asphalt	$0.0525
Birmingham, 50@60% asphalt	.0525
Dallas, 40@50% asphalt	.0512½
Dallas, 50@60% asphalt	.0512½
New York, 40@50% asphalt, (at terminal)	.05
New York, 50@60% asphalt, (at terminal)	.05
St. Louis, 40@50% asphalt	.0342
St. Louis, 50@60% asphalt	.0357

Iron and Steel

PIG IRON—Producers' quotations, per gross ton, f.o.b.:

Birmingham, No. 2 fdry., silicon 1.75@2.25	$15.50
Pittsburgh, basic, incl. freight ($1.76) from Valley	20.26

STRUCTURAL STEEL—Manufacturers' and dealers' quotations per 100 lb.:

	Shapes, 3 to 15-In.	Plates, ¼-In
Birmingham, large mill lots, f.o.b.	$2.15	$2.15
Chicago, warehouse, delivered	3.10	3.10
Cleveland, warehouse, delivered	3.00	3.00
Dallas, warehouse, delivered	3.70	3.70
New York, warehouse, delivered, up to 3,999 lb.	3.30	3.30
Pittsburgh, large mill lots, f.o.b., (Dec. 26, 1929)	1.90	1.90
St. Louis, warehouse, delivered	3.25	3.25
San Francisco, warehouse, delivered	3.40	3.40

BARS, CONCRETE REINFORCING—Manufacturers' and dealers' quotations on bars rolled from billets, per 100 lb. for ½-in.:

Birmingham, large mill lots, f.o.b.	$2.15
Chicago, warehouse, delivered	2.15@3.00
Cleveland, warehouse, delivered	2.25@2.44
Dallas, warehouse, delivered	3.65
New York, warehouse, delivered, over 5 tons	2.20
Pittsburgh, large mill lots, stock lengths, f.o.b.	2.00
St. Louis, warehouse, delivered	3.15
San Francisco, warehouse, delivered	2.25

EXPANDED METAL LATH—Per 100 sq.yd., painted, delivered to job, in less-than-carload lots:

Lb. per Sq. Yd.	New York	Birmingham	Chicago	St. Louis	Dallas	San Francisco
2.2	$18.50	$22.00	$20.50	$21.50	$21.50	$21.50
2.5	19.50	23.00	21.50	22.50	24.00	22.50
3.0	21.00	25.00	23.00	24.00	26.00	25.00
3.4	22.00	26.50	24.00	25.00	30.00	27.00

WIRE REINFORCEMENT FOR CONCRETE—Manufacturers' quotations per 100 sq.ft. in carloads at mills; and delivered by dealers, in lots of 10,000 sq.ft. or over; plain 4 in. by 4 in. mesh:

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Chicago District Mill	Warehouse Delivery: New York	St. Louis	Dallas	San Francisco
032	22	$0.99	$1.01	$1.39	$1.45	$1.13	$1.22
049	28	1.26	1.29	1.76	1.80	1.38	1.55
068	35	1.54	1.58	2.18	2.25	1.67	1.91
093	40	1.98	2.03	2.79	2.95	2.00	2.46
126	57	2.45	2.51	3.45	3.55	2.55	3.03
153	68	2.92	2.99	4.13	4.25	3.15	.....
180	78	3.35	3.43	4.73	4.85	3.47	.....

STEEL SHEETS—Manufacturers' and dealers' quotations per 100 lb., base:

	Blue Annealed No. 10 *	Black No. 24	Galvanized No. 24
Chicago, warehouse, delivered	$3.35	$4.05	$4.90
Cleveland, warehouse, delivered	3.30	3.90	4.75
New York, warehouse, delivered	3.90†	4.90	4.50
Pittsburgh, large mill lots, f.o.b.	2.10@2.20	2.75	3.50@3.50
St. Louis, warehouse, delivered	3.45	4.25	5.10
San Francisco, warehouse, delivered	4.00	5.00	5.40

*Light plates. †Up to 3,999 lb.

WIRE ROPE—Discounts from manufacturers' list price on regular grades of bright and galvanized, Eastern Territory, New York, and East of Missouri River:

	Base
Cast steel round strand rope	20%
Galvanized iron rigging and guy rope (add to list)	12½%
Galvanized steel rigging and guy rope	7½%
Plow steel round strand rope	35%
Round strand iron and iron tiller	5%
"Special Steel" and extra strong cast steel, round strand rope	27½%

Discount 5 points less than discount for Eastern territory: California, Oregon, Nevada, Washington, Wyoming, New Mexico, Colorado, North Dakota, Nebraska, Kansas, Oklahoma and Texas. Discount 10 points less than discount for Eastern territory: Arizona, Montana, Idaho and Utah.

RIVETS—Manufacturers' and dealers' quotations on structural rivets, roundhead, ½-in., full kegs, per 100 lb.:

Chicago, warehouse, delivered	$4.00
Dallas, warehouse, delivered	4.60
New York, warehouse, delivered	4.50*
Pittsburgh, large mill lots, f.o.b.	3.10
St. Louis, warehouse, delivered	4.15
San Francisco, warehouse, delivered	5.00
Seattle, warehouse, delivered	4.25

*This price is for full kegs; broken kegs are $6.00 per 100 lb.

STEEL SHEETPILING—The manufacturers' base price, f.o.b., Pittsburgh, for large mill lots is $2.25 per 100 lb.

TERNE PLATE—I C, 8-lb. coating, 20x28-in., f.o.b., Pittsburgh mill:

Per package	$10.70

SHIP SPIKES—Per 100 lb., black, from dealers' warehouse stocks; galvanized are about $1.75 per 100 lb. higher:

	½-In.	⅝-In.	¾-In.
San Francisco	$5.55	$5.10	$4.95
Seattle	7.75	5.65	5.50

Pittsburgh mill base in lots of 200 kegs or more, $3.00 per 100 lb.

WIRE NAILS—Per 100 lb. keg, base, delivered from warehouse stocks; also Pittsburgh mill base:

Pittsburgh Mill	Birmingham	Chicago	St. Louis	Dallas	San Francisco	Montreal
$2.40@$2.50	$3.30	$2.75	$2.95	$3.75	$3.25	$4.95

SCRAP—The prices following are, f.o.b., per ton, paid by dealers:

	New York Per Gross Ton	Chicago Per Gross Ton	Detroit Per Gross Ton
No. 1 railroad wrought	$11.50@$12.50	$13.00@$13.50	$12.50@$13.00
Stove plate	8.00@8.50	11.00@11.50	10.00
No. 1 machinery cast	10.85	14.50@15.00	12.00*
Machine shop turnings	7.00@7.50	7.00@7.50	8.25
Cast borings	7.00@7.50	9.00@9.50	9.50
Railroad malleable	12.50@13.00	16.00@16.50	13.00
Re-rolling rails	10.50@11.00	15.00@15.50	13.00
Re-laying rails, 56@60 lb.	23.00@24.00	21.00@24.00	.....
Heavy melting steel, No. 1	10.50@11.35	12.50@13.00	12.00
Iron and steel pipe	9.25@9.75	9.00@9.50	10.00

**Net ton.

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant-steel bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carload lots of 36,000 lb. or 18 tons:

Atlanta	$0.58	Detroit	$0.29
Baltimore	.31	Kansas City	.71†
Birmingham	.58	New Orleans	.67
Boston	.365	New York	.34
Buffalo	.265	Pacific Coast (all rail)	1.15*
Chicago	.34	Philadelphia	.32
Cincinnati	.27	St. Louis	.405
Cleveland	.19	St. Paul	.60
Denver	1.15*		

*Minimum weight on structurals, 60,000 lb. †Except iron or steel pipe and fittings.

Railway Materials and Supplies

STEEL RAILS—Manufacturers' quotations per gross ton, f.o.b., for large mill lots:

	Pittsburgh	Birmingham	Chicago
Standard openhearth rails	$43.00	$43.00	$43.00
Light rails, 25 to 45 lb.	36.00	34@36	34@36
Re-rolled rails	34.00	34@36	34@36

RAILWAY TIES—For fair-sized orders, f.o.b., the following prices bold:

		6 In. x 8 In. by 8 Ft.	7 In. x 9 In. by 8½ Ft.
New York	Long-leaf sap pine, untreated	$1.10	$1.30
	Creosoted—prices on application.		
Birmingham	White oak, creosoted	1.52	1.75
	Southern pine, creosoted	1.25	1.60
Chicago	White oak, untreated	1.40	1.78
	Oak, empty cell, creosoted	1.80	2.40
	Oak, zinc treated	1.60	2.10
	Southern pine, creosoted	1.60	2.10
St. Louis	White oak, untreated	1.10	1.70
	Red oak, creosoted	1.50	2.10
	Sap pine or cypress, untreated	.85	1.35
San Francisco	Douglas fir, green, untreated	.87½	1.21
	Douglas fir, empty cell, creosoted	1.60	2.10
Montreal	Birch or maple, untreated	.75@1.25	.75@1.25
	Birch or maple, creosoted	1.20@1.30	1.50@1.60

Current Prices of Construction Materials

Railway Supplies—Continued

TRACK SUPPLIES—Manufacturers' and dealers' quotations per 100 lb., f.o.b., Pittsburgh mill, for large mill lots, together with warehouse prices at other places named:

	Pittsburgh	Chicago	Birmingham	St. Louis	San Francisco
Standard spikes, ⅜-in. and larger	$2.80	$3.55	$3.45	$3.65@$3.75	$4.35
Track bolts	3.80	4.55	5.85	4.65@4.85	5.85
Standard section angle bars, splice bars or fish plates	2.75	3.40	3.75	.....	.....

Tie plates: Price at Pittsburgh and Chicago mills, $2.15 per 100 lb.

Pipe

WROUGHT-STEEL PIPE—Discounts from manufacturers' and dealers' standard lists:

	1 to 3-In. Butt Weld		3½ to 6-In. Lap Weld	
	Black	Galvanized	Black	Galvanized
Chicago, warehouse, delivered	55.5%	42.5%	51.6%	39.0%
Cleveland, warehouse, delivered	55.5%	43.5%	53.5%	40.5%
New York, warehouse, delivered	53.74%	41.2%	50.32%	37.78%
Pittsburgh, large mill lots, f.o.b.	62%	50.5%	59%	47.5%
St. Louis, warehouse, delivered	49%	36%	46%	33%

CAST-IRON PIPE—Prices of U. S. Pipe & Foundry Co., per net ton, for bell and spigot pipe, Class B and heavier, f.o.b., on regular lots of pipe:

	4-In.	6-In. and Over
Birmingham mill	$40.00@$41.00	$37.00@$38.00
Burlington (N. J.) mill	**39.00**	**36.00**
Chicago	48.20@49.20	45.20@46.20
New York	**41.60**	**38.60**
Pittsburgh	48.50@49.50	45.50@46.50
St. Louis	45.60@46.60	42.60@43.60
San Francisco	50.00@51.00	47.00@48.00

Gas pipe and Class A, $3.00 per ton extra.

SEWER PIPE—Prices delivered, per foot, for standard pipe; 6, 8 and 12-in. are single strength and 18, 24, 30 and 36-in. are double strength:

	6-In.	8-In.	12-In.	18-In.	24-In.	30-In.	36-In.
Atlanta	$0.13½	$0.22½	$0.75	....	....	.....	.....
Baltimore	....	.30	.58	....	$1.93	.....	$6.50
Birmingham	.25	.40	.65	$1.50	2.75	$3.90	5.83
Boston	.185	.30	.555	1.35	2.25	3.70	6.50
Chicago	.15	.28	.54	1.25	2.25	4.75	6.00
Cincinnati	.135	.21	.405	1.25	2.025	3.67	5.74
Cleveland	.18	.294	.567	1.35	2.43	4.824	7.38
Dallas	.24	.375	.68	1.60	2.85	.....	.....
Denver	.161	.23	.414	.816	1.44	.....	.....
Detroit	.18	.28	.6075	1.50	2.70	5.12	7.91
Kansas City	.21	.29	.52	....	1.90	3.80	.....
Los Angeles	.21	.2825	.51	1.186	2.03	3.39	5.09
Minneapolis	.16	.25	.50	1.15	1.84	3.49	4.97
Montreal	.36	.53	.78	1.45	2.75	4.20	.....
New Orleans	.195	.325	.585	1.10	2.11	.....	.....
New York	.185	.29	.56	1.35	2.45	4.60	7.07
Philadelphia	.117	.182	.351	1.05	1.89	3.60	5.6375
Pittsburgh	.0945	.147	.2835	.85	1.53	3.024	4.8175
St. Louis	.147	.26	.468	1.092	1.872	3.65	4.80
San Francisco	.1925	.275	.495	1.155	1.98	3.30	4.95
Seattle	.22	.30	.54	1.26	2.16	3.50	.....

CLAY DRAIN TILE—Prices delivered by dealers, per 1,000 lin.ft.:

Size, In.	New York	Birm'ham	St. Louis	Dallas	San Fran.	Seattle
4	$55.00	$56.00	$50.00	$63.00	$67.50	60.00
6	112.00	112.00	85.00	100.00	112.50	112.00

Miscellaneous

LINSEED OIL—Raw oil, f.o.b., in 1- to 4-bbl. lots, per lb.:

New York....**$0.159** Chicago....*$0.159* Minneapolis..*$0.16½*

WHITE AND RED LEAD—Base price per 100-lb. keg, f.o.b., New York: White, dry, $13.75; White, in oil, $14.25; Red, dry, $13.75; Red, in oil, $15.25.

CHEMICALS—Water, sewage treatment, road work, round lots in the New York market:

Sulphate of aluminum, iron free, in bags, per 100 lb.	$2.00@$2.10
Sulphate of copper, in bbl., per 100 lb.	5.50@ 6.00
Soda ash, 58%, in bags, per 100 lb.	1.32@ 1.35
Chlorine, cylinders, per lb.	.04½@ .06
Bleaching powder, in drums, f.o.b. works, per 100 lb.	2.00@ 2.10
Calcium chloride, in drums, f.o.b. works, per ton	20.00

MANILA ROPE—The number of feet per pound for the various sizes is as follows: ½-in., 7-ft., 6-in.; ⅝-in., 6-ft., 1-in.; ¾-in., 4-ft., 5-in.; 1-in., 3-ft., 8-in.; 1¼-in., 2-ft., 5-in.; 1½-in., 1-ft., 8-in. Following prices are quoted by dealers per pound for ½-in. and larger:

Atlanta	$0.25	Kansas City	$0.23
Baltimore	.225	Los Angeles	.205
Birmingham	.26	Minneapolis	.24
Boston	.225	Montreal	.26
Chicago	.22	New Orleans	.25
Cincinnati	.21	New York	.21
Cleveland	.21	Philadelphia	.23
Dallas	.28	San Francisco	.205
Denver	.25	Seattle	.225
Detroit	.23	St. Louis	.215

BUILDING PAPER—Black, in carloads, per roll of 500 sq.ft., f.o.b., producing point **$2.09**

SLATERS FELT—In carloads, per roll, f.o.b., producing point *$0.91*

ROOFING MATERIALS—Prices f.o.b., New York, delivered by dealers to contractors in carloads:

Asphalt felt, per 100 lb.	$2.60
Tar felt, per 100 lb.	2.60
Asphalt coating, per gal.	.34½
Tar pitch, in 350 lb. barrels, per ton	28.00

PREPARED ROOFINGS—Prices delivered by dealers to contractors, in carloads, f.o.b. New York, per square:

Single shingles, slate finish, sufficient to cover 100 sq.ft.	$6.12½
Strip shingles, 4 in 1, hexagonal shape, with Underwriters' label	5.00
Slate surfaced roofing in rolls weighing 85 to 90 lbs.	2.50

WINDOW GLASS—United inches 25, bracket size 6x8 to 10x15, single or double thickness, discount from jobbers' list (Sept. 15, 1928), at New York warehouses:

AA ..... 83% A ..... 86% B 88%

EXPLOSIVES—Manufacturers' quotations per pound for dynamite delivered in small lots, under 200 lb.:

	Gelatin 40%	Gelatin 60%		Gelatin 40%	Gelatin 60%
Atlanta	$0.22	$0.245	Los Angeles, f.o.b.†	$0.1875	$0.2225
Baltimore	.215	.2375	Minneapolis	.2275	.2525
Birmingham	.22	.245	Montreal	.20	.24
Boston	.22	.25	New Orleans	.195	.22
Chicago	.195*	.22*	New York	.255‡	.2775‡
Cincinnati	.22	.245	Philadelphia	.215	.24
Dallas	.1875	.21	St. Louis	.215	.235
Denver, f.o.b.	.19	.2125	San Francisco	.155	.18
Kansas City, Mo.	.2025	.2225	Seattle	.1525	.175

*Quantities above 500 lb. but less than a ton. †San Fernando Arsenal. ‡Special gelatin in case lots.

Lumber

Prices Are Per Thousand Feet, Board Measure

New York—Timbers, rough, delivered to contractor at site of job, in 20 ft. lengths and under, per M. ft., b.m.:

	Merchantable Long-leaf Yellow Pine	No. 1 Common Douglas Fir
3x4 to 8x8	$55.00	$39.00
3x10 to 10x10	65.00	39.00
3x12 to 12x12	75.00	**40.00**
3x14 to 14x14	87.50	47.50

Chicago—Prices, f.o.b., in carloads, No. 1 Common, rough, per M. ft. b.m. For delivery to job from stock, in truckloads, add $10 per M. ft.:

	20 Ft. and Under Long-Leaf Yellow Pine	Up to 32 Ft. Douglas Fir
3x4 to 8x8	$43.00	$42.00
3x10 to 10x10	50.50	42.00
3x12 to 12x12	62.50	42.00
3x14 to 14x14	74.50	43.00

San Francisco—Douglas fir, No. 1 common, rough, at yards. For delivery to contractor at site of job, add $1.50 to $5 per M. ft.:

	10-16-18 and 20 Ft.	For delivery to 22 and 24 Ft.
3x3 and 4	$33.00	$36.00
3x6 and 8	33.00	36.00
3x10 and 12	33.00	36.00
3x14	37.00	39.00

Other Cities—Delivered by dealers, No. 1 Common, rough, per M. ft:

	8x8-In. x 20 Ft. and Under				3x12 to 12x12-In. 20 Ft. and Under	
	Pine*	Fir†	Hem-lock	Spruce	Pine*	Fir†
Atlanta	$55.00	.....	.....	.....	$65.00	.....
Baltimore	36.00	$50.00	$53.50	$61.00	75.00	$50.25
Birmingham	53.00	.....	.....	.....	80.00	.....
Boston	48.50	**47.25**	47.50	48.50	58.00	52.00
Cincinnati	52.50	62.50	.....	.....	70.00	57.50
Cleveland	*63.00*	*63.00*	.....	.....	*63.00*	*63.00*
Dallas	65.00	57.50	55.00	55.00	65.00	55.00
Denver	.....	57.00	57.00	55.00	.....	58.00
Detroit	55.00	53.00	.....	.....	68.50	53.00
Kansas City, Mo.	60.00	60.00	.....	.....	67.00	67.00
Los Angeles	.....	44.00	.....	.....	.....	44.00
Minneapolis	58.00	52.25	38.25‡	.....	58@60	52.25@53.75
Montreal	.....	.....	.....	.....	56.00	48.00
New Orleans	50.00	46.00	.....	44.00	50.00	48.00
Philadelphia	50.00	43.00	42.00	48.00	60.00	43.00
Pittsburgh	65.00	70.00	75.00	65.00	65.00	65@72
St. Louis	*45.00*	*39.00*	.....	.....	*57.00*	*40.00*
Seattle	.....	22.00	.....	.....	.....	21.00

	1x10 In. x 16 Ft. and Under			2x10 In. x 16 Ft. T. & Gr.	
	Pine*	Fir†	Hem-lock	Pine*	Fir†
Atlanta	$60.00	.....	.....	$42.50	.....
Baltimore	56.00	$45.00	$45.00	.....	.....
Birmingham	36.00	.....	.....	45.00	.....
Boston	45.00	43.00	42.50	48.50	$47.50
Cincinnati	65.00	57.50	.....	42.00	55.00
Cleveland	60.00	55.00	.....	65.00	58.00
Dallas	60.00	.....	.....	.....	.....
Denver	.....	45.00	46.00	.....	52.00
Detroit	47.50	45.00	.....	48.50	47.00
Kansas City, Mo.	56.00	56.00	.....	49.00	49.00
Los Angeles	.....	38.00	.....	.....	57.00
Minneapolis	53.00	46.00	39.75‡	51.00	45.00
Montreal	56.00	.....	.....	.....	.....
New Orleans	43.00	40.00	.....	50.00	46.00
Philadelphia	52.00	43.00	41.00	55.00	44.00
Pittsburgh	50.00	60.00	59.00	42.00	.....
St. Louis	*41.00*	*39.00*	*37.00*	**42.00**	**40.00**
Seattle	.....	20.00	.....	.....	21.00

*Long-leaf yellow pine. †Douglas fir. ‡F.o.b.

PILES—Prices of Nichols Bros., 90 West St., N.Y.C. per lineal foot, pine, with bark on, f.o.b., New York; delivered from barge, 1½ to 2c. per ft. additional:

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36
14 in.—2 ft. from butt	5 in.	80 to 85 ft.	.33	.41
14 in.—2 ft. from butt	5 in.	85 to 89 ft.	.25	.41